

PROJECT MANUAL

XXXXX XXXXX (Type in the phase that this spec represents, i.e. CONSTRUCTION DOCUMENTS)

VOLUME 1 - SPECIFICATIONS - SECTIONS 01 THRU 34

UNIVERSITY OF ILLINOIS - SPRINGFIELD

XXX XXX

(Type in the official job name)

ISSUE DATE: XXXXXX XX, 20XX (Type in the issue date for this spec)

PROJECT NUMBER: XXXXXX (Type in is the Architect's Project Number)

XXX

(Add the Architect's Logo)

PROJECT MANUAL

XXXXX XXXXX (Type in the phase that this spec represents, i.e. CONSTRUCTION DOCUMENTS)

VOLUME 2 - SPECIFICATIONS - SECTIONS 15 THRU 34

UNIVERSITY OF ILLINOIS - SPRINGFIELD

XXX XXX

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SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. Work by Owner.
5. Work under separate contracts.
6. Future work.
7. Purchase contracts.
8. Owner-furnished products.
9. Contractor-furnished, Owner-installed products.
10. Access to site.
11. Coordination with occupants.
12. Work restrictions.
13. Specification and Drawing conventions.
14. Miscellaneous provisions.

B. Related Requirements:

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

1.3 PROJECT INFORMATION

A. Project Identification: (Insert Project identifier such as Project name and number).

1. Project Location: (Insert Project location - street address, city, and state).

B. Owner: (Insert name of Owner).

1. Owner's Representative: (Insert name and contact information for Owner's representative).

C. Architect: (Insert name and contact information for Architect).

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

1. (Insert title of design discipline): (Insert name and contact information for consultant).
- E. Other Owner Consultants: Owner has retained the following design professionals who have prepared designated portions of the Contract Documents:
 1. (Insert title of design discipline: Insert name and contact information for consultant. Insert title of design discipline has prepared the following portions of the Contract Documents):
 - a. (Insert description of scope of service for other Owner consultant).
- F. Contractor: (Insert name and contact information for Contractor has been engaged as Contractor for this Project).
- G. Construction Manager: (Insert name and contact information for Construction Manager).
 1. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.
- H. Project Coordinator for Multiple Contracts, if required: (Insert name and contact information for Project coordinator) has been engaged by Owner to serve as Project coordinator.
- I. Project Coordinator for Multiple Contracts: Owner shall serve as Project coordinator.
- J. Web-Based Project Software, if required by Owner: Project software will be used for purposes of managing communication and documents during the construction stage.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
 1. (Insert a brief description of Project indicating the size, code classification for occupancy and construction type, and general description of major building assemblies) and other Work indicated in the Contract Documents.
- B. Type of Contract(s) (Verify with Owner):
 1. Project will be constructed under a single prime contract.
 2. Project will be constructed under coordinated, concurrent multiple contracts.

1.5 PHASED CONSTRUCTION

- A. The Work shall be conducted in (Insert number) phases, with each phase substantially complete as indicated, if required. (Verify with Owner)
 1. Phase (Insert designation): (Briefly describe work of this phase) Work of this phase shall commence within (Insert number of days) after the Notice to Proceed and be substantially complete and ready for occupancy within (Insert number of days) after the Notice to Proceed.
 2. Phase (Insert designation): The remaining Work shall be substantially complete and ready for occupancy at time of Substantial Completion for the Work.

- B. Before commencing Work of each phase, submit an updated copy of Contractor's construction schedule showing the sequence, commencement and completion dates (, and move-out and -in dates of Owner's personnel) for all phases of the Work.

1.6 WORK BY OWNER, IF REQUIRED

- A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Preceding Work: Owner will perform the following construction operations at Project site. Those operations are scheduled to be substantially complete before work under this Contract begins.
 - 1. (Insert a brief description of work performed by Owner).
- C. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with Work under this Contract.
 - 1. (Insert a brief description of work performed by Owner).
- D. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory Work under this Contract.
 - 1. (Insert a brief description of work performed by Owner).

1.7 WORK UNDER SEPARATE CONTRACTS

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

1.8 FUTURE WORK

- A. The Contract Documents include requirements that will allow Owner to carry out future work following completion of this Project; provide for the following future work:
 - 1. (Insert description of future work requiring consideration during construction of the Work of this Contract).

1.9 PURCHASE CONTRACTS

- A. General: Owner has negotiated Purchase contracts with suppliers of material and equipment to be incorporated into the Work. Owner will assign these Purchase contracts to Contractor. Include costs for purchasing, receiving, handling, storage if required, and installation of material and equipment in the Contract Sum unless otherwise indicated.
 - 1. Contractor's responsibilities are same as if Contractor had negotiated Purchase contracts, including responsibility to renegotiate purchase and to execute final purchasing agreements.

1.10 OWNER-FURNISHED PRODUCTS

- A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products and making building services connections.
- B. Owner-Furnished Products:
 - 1. (Insert description, in separate subparagraphs, for each Owner-furnished product).

1.11 CONTRACTOR-FURNISHED, OWNER-INSTALLED PRODUCTS

- A. Contractor shall furnish products indicated. The Work includes unloading, handling, storing, and protecting Contractor-furnished products as directed and turning them over to Owner at Project closeout.

1.12 ACCESS TO SITE

- A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project. (Verify with Owner)
- B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 - 1. Driveways, Walkways and Entrances: Keep driveways, parking garages, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.
- D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.13 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy site and existing and/or adjacent building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.

2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.
- B. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.
- C. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
 3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.14 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of (Insert time) a.m. to (Insert time) p.m., Monday through Friday, unless otherwise indicated.
1. Weekend Hours: (Insert restrictions on times permitted for weekend work).
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
1. Notify Owner not less than two days in advance of proposed utility interruptions.
 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
1. Notify Owner not less than two days in advance of proposed disruptive operations.

2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Restricted Substances: Use of tobacco products and other controlled substances on Project site is not permitted.
 - F. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
 - G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
 1. Maintain list of approved screened personnel with Owner's representative.

1.15 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. 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.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use facsimile of form provided in Project Manual.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions 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 as well as 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, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions 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 seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 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.

1.5 QUALITY ASSURANCE

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

1.6 PROCEDURES

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

1.7 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 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 is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. 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 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Requests for Information (RFI's).
 - 4. Project Web site.
 - 5. Digital project management procedures.
 - 6. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.
 - 4. Section 01 91 13 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.3 DEFINITIONS

- A. BIM: Building Information Modeling.
- B. RFI: Request for Information. Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 2. Number and title of related Specification Section(s) covered by subcontract.
 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
1. Post copies of list in project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in each built facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Coordination: Each contractor shall cooperate with Project coordinator who shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its own operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and scheduled activities of other contractors and direction of Project coordinator to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

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

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
 2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.

5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor-control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 9. Review: Architect will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
 10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 00 "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Preparation Format: DWG, Version, operating in Microsoft Windows operating system.
 3. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format.
 4. BIM File Incorporation: Develop and incorporate coordination drawing files into BIM established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.
 5. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.

- a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
- b. Contractor shall execute a data licensing agreement in the form of AIA Document C106.

1.7 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Architect.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: AIA Document G716.
 1. Attachments shall be electronic files in PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
 1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.

- e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect 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 in writing within 10 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:
 1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Architect's Data Files Not Available: Architect will not provide Architect's BIM model digital data files for Contractor's use during construction.
- B. Use of Architect's Digital Data Files: Digital data files of Architect's BIM model or CAD drawings will be provided by Architect for Contractor's use during construction.
 1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project record Drawings.
 2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 3. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement.
 - a. Subcontractors, and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of AIA Document C106.
 4. The following digital data files will be furnished for each appropriate discipline:
 - a. Floor plans.

- b. Reflected ceiling plans.
- C. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
 - 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 - 2. Name file with submittal number or other unique identifier, including revision identifier.
 - 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.9 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
 - 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
 - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 - 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, and Architect, within three days of the meeting.
- B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
 - 1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Procedures for processing field decisions and Change Orders.
 - h. Procedures for RFIs.
 - i. Procedures for testing and inspecting.
 - j. Procedures for processing Applications for Payment.
 - k. Distribution of the Contract Documents.
 - l. Submittal procedures.
 - m. Sustainable design requirements.
 - n. Preparation of Record Documents.
 - o. Use of the premises and existing building.
 - p. Work restrictions.
 - q. Working hours.
 - r. Owner's occupancy requirements.

- s. Responsibility for temporary facilities and controls.
 - t. Procedures for moisture and mold control.
 - u. Procedures for disruptions and shutdowns.
 - v. Construction waste management and recycling.
 - w. Parking availability.
 - x. Office, work, and storage areas.
 - y. Equipment deliveries and priorities.
 - z. First aid.
 - aa. Security.
 - bb. Progress cleaning.
3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Sustainable Design Requirements Coordination Conference: Owner will schedule and conduct a sustainable design coordination conference before starting construction, at a time convenient to Owner, Architect, and Contractor.
- 1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent and sustainable design coordinator; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Discuss items of significance that could affect meeting sustainable design requirements, including the following:
 - a. Sustainable design Project checklist.
 - b. General requirements for sustainable design-related procurement and documentation.
 - c. Project closeout requirements and sustainable design certification procedures.
 - d. Role of sustainable design coordinator.
 - e. Construction waste management.
 - f. Construction operations and sustainable design requirements and restrictions.
 - 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- D. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, and Owner's Commissioning Authority of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Sustainable design requirements.

- i. Review of mockups.
 - j. Possible conflicts.
 - k. Compatibility requirements.
 - l. Time schedules.
 - m. Weather limitations.
 - n. Manufacturer's written instructions.
 - o. Warranty requirements.
 - p. Compatibility of materials.
 - q. Acceptability of substrates.
 - r. Temporary facilities and controls.
 - s. Space and access limitations.
 - t. Regulations of authorities having jurisdiction.
 - u. Testing and inspecting requirements.
 - v. Installation procedures.
 - w. Coordination with other work.
 - x. Required performance results.
 - y. Protection of adjacent work.
 - z. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- E. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for completing sustainable design documentation.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Coordination of separate contracts.
 - l. Owner's partial occupancy requirements.
 - m. Installation of Owner's furniture, fixtures, and equipment.

- n. Responsibility for removing temporary facilities and controls.
- 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- F. Progress Meetings: Conduct progress meetings at monthly intervals.
 - 1. Coordinate dates of meetings with preparation of payment requests.
 - 2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Status of sustainable design documentation.
 - 6) Deliveries.
 - 7) Off-site fabrication.
 - 8) Access.
 - 9) Site use.
 - 10) Temporary facilities and controls.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of correction of deficient items.
 - 14) Field observations.
 - 15) Status of RFIs.
 - 16) Status of Proposal Requests.
 - 17) Pending changes.
 - 18) Status of Change Orders.
 - 19) Pending claims and disputes.
 - 20) Documentation of information for payment requests.
 - 4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

- G. Coordination Meetings: Conduct Project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site use.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Status of RFIs.
 - 15) Proposal Requests.
 - 16) Change Orders.
 - 17) Pending changes.
 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.10 PROJECT WEB SITE

- A. Use Owner's Project Web site 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. Contract modifications forms and logs.
5. RFI forms and logs.
6. Schedule and calendar management.
7. Submittals forms and logs.
8. Payment application forms.
9. Drawing and specification document hosting, viewing, and updating.
10. Online document collaboration.
11. Archiving functions.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Startup construction schedule.
 - 2. Contractor's Construction Schedule.
 - 3. Construction schedule updating reports.
 - 4. Daily construction reports.
 - 5. Material location reports.
 - 6. Site condition reports.
 - 7. Unusual event reports.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.

2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

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

1. Working electronic copy of schedule file, where indicated.
2. PDF file.
3. Two paper copies, of sufficient size to display entire period or schedule, as required.

B. Startup construction schedule.

1. Submittal of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.

C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.

E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
3. Total Float Report: List of activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Award until most recent Application for Payment.

F. Construction Schedule Updating Reports: Submit with Applications for Payment.

G. Daily Construction Reports: Submit at weekly intervals.

H. Material Location Reports: Submit at weekly intervals.

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

J. Unusual Event Reports: Submit at time of unusual event.

- K. Qualification Data: For scheduling consultant.

1.5 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's Construction Schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including phasing, work stages, interim milestones, and partial Owner occupancy.
 - 4. Review delivery dates for Owner-furnished products.
 - 5. Review schedule for work of Owner's separate contracts.
 - 6. Review submittal requirements and procedures.
 - 7. Review time required for review of submittals and resubmittals.
 - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 9. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

1.7 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- B. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
 - 1. In-House Option: Owner may waive requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 - 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.

- C. Time Frame: Extend schedule from date established for the Notice of Award to date of Substantial Completion.
1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- D. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 5. Commissioning Time: Include no fewer than 15 days for commissioning.
 6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 7. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
- E. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 6. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.
 - e. Use-of-premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.

- b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
 - n. Commissioning.
8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
- a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
9. Other Constraints:
- F. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Award, Substantial Completion, and final completion.
- G. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
1. See Section 01 29 00 "Payment Procedures" for cost reporting and payment procedures.
- H. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and the Contract Time.
- I. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.

- J. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- K. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.8 STARTUP CONSTRUCTION SCHEDULE

- A. Gantt-Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within seven days of date established for the Notice to Award.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

1.9 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice to Award.
 - 1. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
 - 1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

1.10 CPM SCHEDULE REQUIREMENTS

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Startup Network Diagram: Submit diagram within 14 days of date established for the Notice to Award. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's Construction Schedule using a cost- and resource-loaded, time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for the Notice to Award.
 - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates.
 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing and inspection.
 - j. Commissioning.
 - k. Punch list and final completion.
 - l. Activities occurring following final completion.
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
 5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, sustainable design documentation, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.

- a. Each activity cost shall reflect an appropriate value subject to approval by Architect.
 - b. Total cost assigned to activities shall equal the total Contract Sum.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.
- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
 1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
 1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.
- H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
 1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

1.11 REPORTS

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

1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Testing and inspection.
 8. Accidents.
 9. Meetings and significant decisions.
 10. Unusual events.
 11. Stoppages, delays, shortages, and losses.
 12. Meter readings and similar recordings.
 13. Emergency procedures.
 14. Orders and requests of authorities having jurisdiction.
 15. Change Orders received and implemented.
 16. Construction Change Directives received and implemented.
 17. Services connected and disconnected.
 18. Equipment or system tests and startups.
 19. Partial completions and occupancies.
 20. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
1. Submit unusual event reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
 - 3. Final completion construction photographs.
 - 4. Preconstruction video recordings.
 - 5. Periodic construction video recordings.
 - 6. Construction webcam.
- B. Related Requirements:
 - 1. Section 01 77 00 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
 - 2. Section 01 79 00 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
 - 3. Section 02 41 19 "Selective Demolition" for photographic documentation before selective demolition operations commence.

1.3 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Submit photos on CD-ROM or thumb-drive or by uploading to web-based project software site. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description in file metadata tag or in web-based project software site:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of location, vantage point, and direction.
 - g. Unique sequential identifier keyed to accompanying key plan.

- C. Printed Photographs: Submit two sets of prints of each photographic view within seven days of taking photographs.
1. Format: 8-by-10-inch (203-by-254-mm) smooth-surface matte prints on single-weight, paper; enclosed back to back in clear plastic sleeves punched for three-ring binder. Include copy of key plan indicating each photograph's location and direction. Provide one binder for each set of prints.
 2. Identification: On back of each print, label with the following information:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken if not date stamped by camera.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.
- D. Video Recordings: Submit video recordings within seven days of recording.
1. Submit video recordings on CD-ROM or thumb drive or by uploading to web-based project software site. Include copy of key plan indicating each video's location and direction.
 2. Identification: With each submittal, provide the following information in file metadata tag or on web-based project software site:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date video recording was recorded.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 3. Transcript: Prepared on 8-1/2-by-11-inch (215-by-280-mm) paper, punched and bound in three-ring binders. Provide label on front and spine. Include a cover sheet with label information. Include name of Project and date of video recording on each page.

1.4 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.
- B. Construction Webcam Service Provider: A firm specializing in providing photographic equipment, web-based software, and related services for construction projects, with record of providing satisfactory services similar to those required for Project.

1.5 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.

- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full high-definition mode with vibration-reduction technology. Provide supplemental lighting in low light levels or backlit conditions.
- C. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- D. Metadata: Record accurate date and time and GPS location data from camera.
- E. File Names: Name media files with date and sequential numbering suffix.

1.6 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified photographer to take construction photographs.
- B. General: Take photographs with maximum depth of field and in focus.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Preconstruction Photographs: Before commencement of excavation (or start of demolition, typically), take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 - 1. Flag excavation areas before taking construction photographs.
 - 2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- D. Periodic Construction Photographs: Take 20 photographs weekly. Select vantage points to show status of construction and progress since last photographs were taken.
- E. Final Completion Construction Photographs: Take 20 photographs after date of Substantial Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.
- F. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum or in the allowance for construction photographs.
 - 1. Three days' notice will be given, where feasible.
 - 2. In emergency situations, take additional photographs within 24 hours of request.
 - 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Substantial Completion of a major phase or component of the Work.

- e. Extra record photographs at time of final acceptance.
- f. Owner's request for special publicity photographs.

1.7 CONSTRUCTION VIDEO RECORDINGS

- A. Video Recording Photographer: Engage a qualified videographer to record construction video recordings.
- B. Transcript: Provide a typewritten transcript of the narration. Display images and running time captured from video recording opposite the corresponding narration segment.
- C. Preconstruction Video Recording: Before starting excavation, record video recording of Project site and surrounding properties from different vantage points, as directed by Architect.
 - 1. Flag excavation areas before recording construction video recordings.
 - 2. Show existing conditions adjacent to Project site before starting the Work.
 - 3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of excavation.
 - 4. Show protection efforts by Contractor.
- D. Periodic Construction Video Recordings: Record video recording monthly. Select vantage points to show status of construction and progress since last video recordings were recorded. Minimum recording time shall be 30 minutes.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Requirements:

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

1.3 DEFINITIONS

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

- D. 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.

1.4 SUBMITTAL SCHEDULE

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

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.
 - g. Scheduled dates for purchasing.
 - h. Scheduled date of fabrication.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.5 SUBMITTAL FORMATS

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

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

9. Category and type of submittal.
 10. Submittal purpose and description.
 11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
 12. Drawing number and detail references, as appropriate.
 13. Indication of full or partial submittal.
 14. Location(s) where product is to be installed, as appropriate.
 15. Other necessary identification.
 16. Remarks.
 17. Signature of transmitter.
- B. Options: Identify options requiring selection by Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Paper Submittals:
1. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
 2. Provide a space approximately 6 by 8 inches (150 by 200 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
 3. Action Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect, will return two copies.
 4. Informational Submittals: Submit two paper copies of each submittal unless otherwise indicated. Architect will not return copies.
 5. Additional Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
 6. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using AIA Document G810 transmittal form.
- E. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.6 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Email: Prepare submittals as PDF package, and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
 - a. Architect will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
 2. Paper: Prepare submittals in paper form, and deliver to Architect.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 calendar 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 15 calendar 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 21 calendar days for initial review of each submittal.
 5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 calendar days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.
 - a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.
- 1.7 SUBMITTAL REQUIREMENTS
- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Architect's digital data drawing files is otherwise permitted.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm), but no larger than 30 by 42 inches (750 by 1067 mm).
 3. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.

- b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
 3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
 4. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
 5. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 6. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
 7. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.

4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Electronic Submittals:
 1. Post electronic submittals as PDF electronic files directly to Project Web site specifically established for Project.
 2. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
- H. Certificates:
 1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
 5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
 6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- I. Test and Research Reports:
 1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
 2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
 3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
 4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.8 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file 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.
- C. BIM Incorporation: Incorporate delegated-design drawing and data files into BIM established for Project.
 1. Prepare delegated-design drawings in the following format: Same digital data software program, version, and operating system as original Drawings.

1.9 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.10 ARCHITECT'S REVIEW

- A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return it.
 - 1. PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action.
 - 2. Paper Submittals: Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Architect will return without review submittals received from sources other than Contractor.
- F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 33 00

SECTION 01 35 16 - ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes special procedures for alteration work.

1.3 DEFINITIONS

- A. Alteration Work: This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
- B. Consolidate: To strengthen loose or deteriorated materials in place.
- C. Design Reference Sample: A sample that represents the Architect's prebid selection of work to be matched; it may be existing work or work specially produced for the Project.
- D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Architect.
- F. Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.
- G. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- H. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- I. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.
- J. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- K. Retain: To keep existing items that are not to be removed or dismantled.
- L. Strip: To remove existing finish down to base material unless otherwise indicated.

1.4 COORDINATION

- A. Alteration Work Subschedule: A construction schedule coordinating the sequencing and scheduling of alteration work for entire Project, including each activity to be performed, and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for alteration work.
1. Schedule construction operations in sequence required to obtain best Work results.
 2. Coordinate sequence of alteration work activities to accommodate the following:
 - a. Owner's continuing occupancy of portions of existing building.
 - b. Owner's partial occupancy of completed Work.
 - c. Other known work in progress.
 - d. Tests and inspections.
 3. Detail sequence of alteration work, with start and end dates.
 4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
 5. Use of elevator and stairs.
 6. Equipment Data: List gross loaded weight, axle-load distribution, and wheel-base dimension data for mobile and heavy equipment proposed for use in existing structure. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.
- B. Pedestrian and Vehicular Circulation: Coordinate alteration work with circulation patterns within Project building(s) and site. Some work is near circulation patterns and adjacent to restricted areas. Circulation patterns cannot be closed off entirely and in places can be only temporarily redirected around small areas of work. Access to restricted areas may not be obstructed. Plan and execute the Work accordingly.

1.5 PROJECT MEETINGS FOR ALTERATION WORK

- A. Preliminary Conference for Alteration Work: Before starting alteration work, conduct conference at Project site.
1. Attendees: In addition to representatives of Owner, Architect, and Contractor, testing service representative, specialists, and chemical-cleaner manufacturer(s) shall be represented at the meeting.
 2. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:
 - a. Alteration Work Subschedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Fire-prevention plan.
 - c. Governing regulations.
 - d. Areas where existing construction is to remain and the required protection.
 - e. Hauling routes.
 - f. Sequence of alteration work operations.
 - g. Storage, protection, and accounting for salvaged and specially fabricated items.
 - h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
 - i. Qualifications of personnel assigned to alteration work and assigned duties.
 - j. Requirements for extent and quality of work, tolerances, and required clearances.

- k. Embedded work such as flashings and lintels, special details, collection of waste, protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.
 3. Reporting: Record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.
- B. Coordination Meetings: Conduct coordination meetings specifically for alteration work at weekly intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner, Architect, and Contractor, each specialist, supplier, installer, and other entity concerned with progress or involved in planning, coordination, or performance of alteration work activities shall be represented at these meetings. All participants at conference shall be familiar with Project and authorized to conclude matters relating to alteration work.
 2. Agenda: Review and correct or approve minutes of previous coordination meeting. Review other items of significance that could affect progress of alteration work. Include topics for discussion as appropriate to status of Project.
 - a. Alteration Work Subschedule: Review progress since last coordination meeting. Determine whether each schedule item is on time, ahead of schedule, or behind schedule. Determine how construction behind schedule will be expedited with retention of quality; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities are completed within the Contract Time.
 - b. Schedule Updating: Revise Contractor's Alteration Work Subschedule after each coordination meeting where revisions to schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each entity present, including review items listed in the "Preliminary Conference for Alteration Work" Paragraph in this article and the following:
 - 1) Interface requirements of alteration work with other Project Work.
 - 2) Status of submittals for alteration work.
 - 3) Access to alteration work locations.
 - 4) Effectiveness of fire-prevention plan.
 - 5) Quality and work standards of alteration work.
 - 6) Change Orders for alteration work.
 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.6 MATERIALS OWNERSHIP

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain Owner's property.
1. Carefully dismantle and salvage each item or object in a manner to prevent damage and protect it from damage, then promptly deliver it to Owner where directed at Project site.

1.7 INFORMATIONAL SUBMITTALS

- A. Alteration Work Subschedule:
 - 1. Submit alteration work subschedule within 30 days of date established for commencement of alteration work.
- B. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements that are to remain, including finish surfaces, that might be misconstrued as damage caused by Contractor's alteration work operations.
- C. Alteration Work Program: Submit 30 days before work begins.
- D. Fire-Prevention Plan: Submit 30 days before work begins.

1.8 QUALITY ASSURANCE

- A. Specialist Qualifications: An experienced firm regularly engaged in specialty work similar in nature, materials, design, and extent to alteration work as specified in each Section and that has completed a minimum of five recent projects with a record of successful in-service performance that demonstrates the firm's qualifications to perform this work.
 - 1. Field Supervisor Qualifications: Full-time supervisors experienced in specialty work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on-site when specialty work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond the control of the specialist firm.
 - a. Construct new mockups of required work whenever a supervisor is replaced.
- B. Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a "Lead-Safe Certified Firm" according to 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe work practices.
- C. Alteration Work Program: Prepare a written plan for alteration work for whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project alteration work program with specific requirements of programs required in other alteration work Sections.
 - 1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
 - 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
- D. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Coordinate plan with Owner's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.
- E. Safety and Health Standard: Comply with ANSI/ASSE A10.6.

1.9 STORAGE AND HANDLING OF SALVAGED MATERIALS

A. Salvaged Materials:

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

B. Salvaged Materials for Reinstallation:

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

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

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

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

E. Storage Space:

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

1.10 FIELD CONDITIONS

A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of measured drawings and preconstruction videotapes.

1. Comply with requirements specified in Section 013233 "Photographic Documentation."

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

C. Size Limitations in Existing Spaces: Materials, products, and equipment used for performing the Work and for transporting debris, materials, and products shall be of sizes that clear surfaces

within existing spaces, areas, rooms, and openings, including temporary protection, by 12 inches (300 mm) or more.

PART 2 - PRODUCTS - (Not Used)

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.
 - 1. Use only proven protection methods, appropriate to each area and surface being protected.
 - 2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration work is being performed.
 - 3. Erect temporary barriers to form and maintain fire-egress routes.
 - 4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration work.
 - 5. Contain dust and debris generated by alteration work, and prevent it from reaching the public or adjacent surfaces.
 - 6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
 - 7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
 - 8. Provide supplemental sound-control treatment to isolate demolition work from other areas of the building.
- B. Temporary Protection of Materials to Remain:
 - 1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
 - 2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Utility and Communications Services:
 - 1. Notify Owner, Architect, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration work before commencing operations.
 - 2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration work.
 - 3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.

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

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

3.2 PROTECTION FROM FIRE

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

1. Comply with NFPA 241 requirements unless otherwise indicated. Perform duties titled "Owner's Responsibility for Fire Protection."
2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.
 - a. If combustible material cannot be removed, provide fire blankets to cover such materials.

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

1. Use of open-flame equipment is not permitted.
2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
 - a. Train each fire watch in the proper operation of fire-control equipment and alarms.
 - b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
 - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
 - d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
 - e. Maintain fire-watch personnel at each area of Project site until two hours after conclusion of daily work.

- C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.
- D. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.
 - 1. Remove temporary guards at the end of work shifts, whenever operations are paused, and when nearby work is complete.

3.3 PROTECTION DURING APPLICATION OF CHEMICALS

- A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.
- B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in alteration work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.
- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize alkaline and acid wastes and legally dispose of off Owner's property.
- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

3.4 GENERAL ALTERATION WORK

- A. Have specialty work performed only by qualified specialists.
- B. Ensure that supervisory personnel are present when work begins and during its progress.
- C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs or video recordings. Comply with requirements in Section 01 32 33 "Photographic Documentation."
- D. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.
- E. Notify Architect of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
 - 1. Do not proceed with the work in question until directed by Architect.

END OF SECTION 01 35 16

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities

of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Laboratory Mockups: Full-size physical assemblies constructed and tested at testing facility to verify performance characteristics.
 2. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements or as part of permanent construction, consisting of multiple products, assemblies, and subassemblies.
 3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes; doors; windows; millwork; casework; specialties; furnishings and equipment; and lighting.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.4 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.5 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent

requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.

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

1.6 ACTION SUBMITTALS

- A. Shop Drawings: For mockups.
 - 1. Include plans, sections, and elevations, indicating materials and size of mockup construction.
 - 2. Indicate manufacturer and model number of individual components.
 - 3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
- B. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.

6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

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

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice of Award, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
1. Project quality-control manager shall not have other Project responsibilities.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
 3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by Commissioning Authority.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
 2. Project title and number.
 3. Name, address, telephone number, and email address of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

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

- B. **Manufacturer Qualifications:** A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. **Fabricator Qualifications:** A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. **Specialists:** Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. **Testing Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.

- d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups of size indicated.
 2. Build mockups in location indicated or, if not indicated, as directed by Architect.
 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
 5. Demonstrate the proposed range of aesthetic effects and workmanship.
 6. Obtain Architect's approval of mockups before starting corresponding work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 8. Demolish and remove mockups when directed unless otherwise indicated.
- L. Integrated Exterior Mockups: Construct integrated exterior mockup according to approved Shop Drawings or as indicated on Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials. Comply with requirements in "Mockups" Paragraph.
- M. Room Mockups: Construct room mockups according to approved Shop Drawings or as indicated on Drawings incorporating required materials and assemblies, finished according to requirements. Provide required lighting and additional lighting where required to enable Architect to evaluate quality of the Work. Comply with requirements in "Mockups" Paragraph.
- 1.11 QUALITY CONTROL
- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 2. Payment for these services will be made from testing and inspection allowances, as authorized by Change Orders.

3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.
- E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."
- F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

- G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspection equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage (unless otherwise specified that the Contractor will engage) a qualified testing agency and/or special inspector if required to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, as indicated in the Statement of Special Inspections attached to this Section, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work.

- B. Special Tests and Inspections: Conducted by a qualified testing agency or special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections and in the Statement of Special Inspections attached to this Section, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's and Commissioning Authority's, reference during normal working hours.
1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities 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."
- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Abbreviations and acronyms not included in this list 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." The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. AABC - Associated Air Balance Council; www.aabc.com.
 2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
 3. 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 - Conformance 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.floridarroof.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.smpite.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.turfgrassod.org.
 194. TRI - Tile Roofing Institute; www.tilerooting.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.
- C. 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 für 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.
- D. 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.
- E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
 2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.
 3. DSCC - Defense Supply Center Columbus; (See FS).
 4. FED-STD - Federal Standard; (See FS).
 5. FS - Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.
 6. MILSPEC - Military Specification and Standards; (See DOD).
 7. USAB - United States Access Board; www.access-board.gov.
 8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).
- F. 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.txforestservation.tamu.edu.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations (unless otherwise specified).
- C. Water Service: Pay water-service use charges for water used by all entities for construction operations (unless otherwise specified).
- D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations (unless otherwise specified).
- E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations (unless otherwise specified).
- F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations (unless otherwise specified).

1.4 INFORMATIONAL SUBMITTALS

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

- B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
- C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- D. Erosion- and Sedimentation-Control Plan (unless otherwise specified): Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- E. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- F. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.
- G. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
 - 1. Locations of dust-control partitions at each phase of work.
 - 2. HVAC system isolation schematic drawing.
 - 3. Location of proposed air-filtration system discharge.
 - 4. Waste-handling procedures.
 - 5. Other dust-control measures.

1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.6 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Chain-Link Fencing (if required and/or specified): Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top rails.
- B. Portable Chain-Link Fencing (if required and/or specified): Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top and bottom rails. Provide galvanized-steel bases for supporting posts.
- C. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.
- D. Wood Enclosure Fence: Plywood, 6 feet (1.8 m) high, framed with four 2-by-4-inch (50-by-100-mm) rails, with preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart.
- E. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil (0.25-mm) minimum thickness, with flame-spread rating of 15 or less per ASTM E84 and passing NFPA 701 Test Method 2.
- F. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats minimum 36 by 60 inches (914 by 1524 mm).
- G. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Conference room of sufficient size to accommodate meetings of 12 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack and marker boards.
 - 3. Drinking water and private toilet.
 - 4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
 - 5. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.

- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
 - 1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - 1. Install electric power service underground unless otherwise indicated.
 - 2. Connect temporary service to Owner's existing power source, as directed by Owner.

- H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- I. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install WiFi cell phone access equipment and one land-based telephone line for each field office.
1. Provide additional telephone lines for the following:
 - a. Provide one telephone line for Owner's use.
 2. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Engineers' offices.
 - g. Owner's office.
 - h. Principal subcontractors' field and home offices.
- J. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:
1. Processor: Intel Core i5 or i7.
 2. Memory: 4 gigabyte.
 3. Disk Storage: 500 gigabyte hard-disk drive and combination DVD-RW/CD-RW drive.
 4. Display: 24-inch (610-mm) LCD monitor with 256-Mb dedicated video RAM.
 5. Full-size keyboard and mouse.
 6. Network Connectivity: Gigabit.
 7. Operating System: Microsoft Windows 7 Professional.
 8. Productivity Software:
 - a. Microsoft Office Professional, 2010 or higher, including Word, Excel, and Outlook.
 - b. Adobe Reader 11.0 or higher.
 - c. WinZip 7.0 or higher.
 9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
 10. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 1.0 Mbps upload and 15 Mbps download speeds at each computer.
 11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
 12. Backup: External hard drive, minimum 2 terabyte, with automated backup software providing daily backups.

3.4 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:

1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E136. Comply with NFPA 241.
 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated on Drawings.
1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 31 20 00 "Earth Moving."
 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Section 32 12 16 "Asphalt Paving."
- D. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- E. Parking: Provide temporary parking areas for construction personnel.
- F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 2. Remove snow and ice as required to minimize accumulations.
- G. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
1. Identification Signs: Provide Project identification signs as indicated on Drawings.
 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 3. Maintain and touch up signs so they are legible at all times.

- H. Waste Disposal Facilities: Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."
 - I. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 01 73 00 "Execution."
 - J. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
 - K. Temporary Elevator Use: See Section 14 21 00 "Electric Traction Elevators" for temporary use of new elevators.
 - L. Existing Elevator Use will not be permitted unless written permission is granted by Owner: If allowed, use of Owner's existing elevators will only be permitted, provided elevators are cleaned every day and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
 - 1. Do not load elevators beyond their rated weight capacity.
 - 2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
 - M. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
 - N. Existing Stair Usage: Use of Owner's existing stairs will be permitted if written permission is granted by Owner, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
 - 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.
 - O. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.
- 3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION
- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
 - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - 1. Comply with work restrictions specified in Section 01 10 00 "Summary."
- C. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 31 10 00 "Site Clearing."
- D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
 - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- E. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- F. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- G. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- H. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations and/or as indicated on Drawings.
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.
- I. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- K. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

- L. Covered Walkway if shown: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction and requirements indicated on Drawings.
1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
 2. Paint and maintain appearance of walkway for duration of the Work.
- M. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- N. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner and tenants from fumes and noise.
1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side if shown.
 2. Construct dustproof partitions with two layers of 6-mil (0.14-mm) polyethylene sheet on each side. Cover floor with two layers of 6-mil (0.14-mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors. Maintain water-dampened foot mats in vestibule.
 3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 4. Insulate partitions to control noise transmission to occupied areas.
 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 6. Protect air-handling equipment.
 7. Provide walk-off mats at each entrance through temporary partition.
- O. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
 3. Indicate methods to be used to avoid trapping water in finished work.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard and replace stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.7 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 - 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 - 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 58 00 - PROJECT IDENTIFICATION AND SIGNS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY:

- A. The General Contractor shall:
 - 1. Furnish, install and maintain project identification sign.
 - 2. Provide temporary on-site informational signs to identify key elements of construction facilities.
 - 3. Remove signs on completion of construction.
 - 4. Allow no other signs to be displayed.
 - 5. Secure permit for sign installation.
- B. RELATED SECTIONS: The following sections contain requirements that relate to this section:
 - 1. Division 1 for 01 10 00 - Summary.
 - 2. Division 6 for Carpentry
 - 3. Division 9 for Painting

1.3 PROJECT IDENTIFICATION SIGN:

- A. One painted sign of size, design, lettering and construction as shown at end of section.
- B. Materials:
 - 1. Sheet Face: 3/4" plastic overlay plywood
 - 2. Posts: Sized to resist 50 mph wind, but not less than nominal 4" x 4" pressure treated wood.
 - 3. Cross Framing: 2 x treated wood.
- C. Size: 4' x 8'
- D. Project Sign will include:
 - 1. Name of Project and Graphic
 - 2. Owner's name and logo
 - 3. Architect's name and logo
 - 4. Architect's consultant's names and logos

5. Prime Contractor's name
6. Etc. as directed by Architect

- E. Mounting height, letter styles and heights and colors shall be as directed by the Architect.
- F. Other signs or advertisements shall not be displayed unless authorized by the Architect.

1.4 INFORMATIONAL SIGNS:

- A. Painted signs with painted lettering, or standard products.
 1. Size of signs and lettering: as required by regulatory agencies, or as appropriate to usage.
 2. Colors: As required by regulatory agencies, otherwise of uniform colors throughout project.
- B. Erect at appropriate locations to provide required information.

1.5 QUALITY ASSURANCE:

- A. Sign Painter: Professional Experience in type of work required.
- B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

PART 2 - PRODUCTS

2.1 SIGN MATERIALS:

- A. Structure and Framing: Shall be new wood construction structurally adequate to work and suitable for specified finish.
- B. Sign Surfaces: Exterior softwood plywood with medium density overlay, standard large sizes to minimize joints.
 1. Thickness: As required by standards to span framing members, to provide even, smooth surface without waves or buckles.
- C. Rough Hardware: Galvanized
- D. Paint: Exterior quality, as specified in Division 9 Section - Painting.
 1. Colors for structure, framing, sign surfaces and graphics: As selected by Architect/Engineer.

PART 3 - EXECUTION

3.1 INFORMATIONAL SIGNS:

- A. Paint exposed surfaces; one coat of primer and one coat of exterior paint.
- B. Paint graphics in styles, sizes and colors selected.

- C. Install at a height for optimum visibility, on ground-mounted poles or attached to temporary structural surfaces.

3.2 MAINTENANCE:

- A. Maintain signs and supports in a neat, clean condition; repair damages to structure, framing or sign.
- B. Relocate informational signs as required by progress of the work.

3.3 REMOVAL:

- A. Remove signs, framing, supports and foundations at completion of project.

END SECTION 01 58 00

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 01 25 00 "Substitution Procedures" for requests for substitutions.
 - 2. Section 01 42 00 "References" for applicable industry standards for products specified.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved by Architect through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that

does meet the requirements of the specifications. Submit a comparable product request, if applicable.

1.4 ACTION SUBMITTALS

- A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Form of Architect's Approval of Submittal: As specified in Section 01 33 00 "Submittal Procedures."
 - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.

3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 6. Protect stored products from damage and liquids from freezing.
 7. Provide a secure location and enclosure at Project site for storage of materials and equipment 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 warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for 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 with the Specifications, prepare a written document using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Architect, whose determination is final.
- B. Product Selection Procedures:
1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: ..."
 2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: ..."
 3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with

- requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
- a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: ..."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
 - a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: ..."
 5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: ..."
 6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: ..."
 7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 01 25 00 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.
 - D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 2. Evidence that proposed product provides specified warranty.
 3. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 4. Samples, if requested.
- B. Submittal Requirements: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner-installed products.
6. Progress cleaning.
7. Starting and adjusting.
8. Protection of installed construction.

- B. Related Requirements:

1. Section 01 10 00 "Summary" for limits on use of Project site.
2. Section 01 33 00 "Submittal Procedures" for submitting surveys.
3. Section 01 77 00 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.4 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at Project site.
 1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:

- a. Contractor's superintendent.
 - b. Trade supervisor responsible for cutting operations.
 - c. Trade supervisor(s) responsible for patching of each type of substrate.
 - d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affecting by cutting and patching operations.
2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor.
- B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
- C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 4. Dates: Indicate when cutting and patching will be performed.
 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.
- D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- E. Certified Surveys: Submit two copies signed by land surveyor.
- F. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.6 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut

- and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
 - a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Fire-suppression systems.
 - e. Plumbing piping systems.
 - f. Mechanical systems piping and ducts.
 - g. Control systems.
 - h. Communication systems.
 - i. Fire-detection and -alarm systems.
 - j. Conveying systems.
 - k. Electrical wiring systems.
 - l. Operating systems of special construction.
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
 - a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.
 - c. Exterior curtain-wall construction.
 - d. Sprayed fire-resistive material.
 - e. Equipment supports.
 - f. Piping, ductwork, vessels, and equipment.
 - g. Noise- and vibration-control elements and systems.
 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
 1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.

- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services; and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

- B. **Field Measurements:** Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. **Space Requirements:** Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. **Review of Contract Documents and Field Conditions:** Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 01 31 00 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. **Verification:** Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. **General:** Engage a land surveyor to lay out the Work using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish limits on use of Project site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. **Site Improvements:** Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. **Building Lines and Levels:** Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. **Record Log:** Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. **Identification:** Owner will identify existing benchmarks, control points, and property corners.

- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
 - 1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 - 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Repair or remove and replace damaged, defective, or nonconforming Work.
 - 1. Comply with Section 01 77 00 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.6 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 01 10 00 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 - 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 - 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
 - I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 50 00 "Temporary Facilities and Controls." And Section 01 74 19 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.9 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 01 73 00

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.
 - 2. Section 31 10 00 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 7 days of date established for the Notice of Award.

1.6 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-7 for construction waste and Form CWM-8 for demolition waste. Include the following information:
 - 1. Material category.
 - 2. Generation point of waste.
 - 3. Total quantity of waste in tons (tonnes).
 - 4. Quantity of waste salvaged, both estimated and actual in tons (tonnes).
 - 5. Quantity of waste recycled, both estimated and actual in tons (tonnes).
 - 6. Total quantity of waste recovered (salvaged plus recycled) in tons (tonnes).
 - 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- G. LEED Submittal: Submit documentation to USGBC, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met. Respond to questions and requests from USGBC regarding construction waste management and disposal until the USGBC has made its determination on the Project's LEED certification application. Document correspondence with USGBC as informational submittals.
- H. Qualification Data: For waste management coordinator and refrigerant recovery technician.

- I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- J. Refrigerant Recovery: Comply with requirements in Section 02 41 19 "Selective Demolition" for refrigerant recovery submittals.

1.7 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent may not serve as Waste Management Coordinator.
 - 1. Firm employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator.
 - 2. Waste management coordinator may also serve as LEED coordinator.
- B. Refrigerant Recovery Technician Qualifications: Universal certified by EPA-approved certification program.
- C. Refrigerant Recovery Technician Qualifications: Comply with requirements in Section 02 41 19 "Selective Demolition."
- D. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.
- E. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
 - 2. Review requirements for documenting quantities of each type of waste and its disposition.
 - 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 - 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 - 5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. Include estimated quantities and assumptions for estimates.

- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use Form CWM-3 for construction waste and Form CWM-4 for demolition waste. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in compliance with Section 02 41 19 "Selective Demolition."
 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.
- D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there were no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use Form CWM-5 for construction waste and Form CWM-6 for demolition waste. Include the following:
1. Total quantity of waste.
 2. Estimated cost of disposal (cost per unit). Include transportation and tipping fees and cost of collection containers and handling for each type of waste.
 3. Total cost of disposal (with no waste management).
 4. Revenue from salvaged materials.
 5. Revenue from recycled materials.
 6. Savings in transportation and tipping fees by donating materials.
 7. Savings in transportation and tipping fees that are avoided.
 8. Handling and transportation costs. Include cost of collection containers for each type of waste.
 9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 50 or 75 (verify with Owner) percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:
1. Demolition Waste:
 - a. Asphalt paving.
 - b. Concrete.
 - c. Concrete reinforcing steel.

- d. Brick.
- e. Concrete masonry units.
- f. Wood studs.
- g. Wood joists.
- h. Plywood and oriented strand board.
- i. Wood paneling.
- j. Wood trim.
- k. Structural and miscellaneous steel.
- l. Rough hardware.
- m. Roofing.
- n. Insulation.
- o. Doors and frames.
- p. Door hardware.
- q. Windows.
- r. Glazing.
- s. Metal studs.
- t. Gypsum board.
- u. Acoustical tile and panels.
- v. Carpet.
- w. Carpet pad.
- x. Demountable partitions.
- y. Equipment.
- z. Cabinets.
- aa. Plumbing fixtures.
- bb. Piping.
- cc. Supports and hangers.
- dd. Valves.
- ee. Sprinklers.
- ff. Mechanical equipment.
- gg. Refrigerants.
- hh. Electrical conduit.
- ii. Copper wiring.
- jj. Lighting fixtures.
- kk. Lamps.
- ll. Ballasts.
- mm. Electrical devices.
- nn. Switchgear and panelboards.
- oo. Transformers.

2. Construction Waste:

- a. Masonry and CMU.
- b. Lumber.
- c. Wood sheet materials.
- d. Wood trim.
- e. Metals.
- f. Roofing.
- g. Insulation.
- h. Carpet and pad.
- i. Gypsum board.
- j. Piping.
- k. Electrical conduit.
- l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

- 1) Paper.
- 2) Cardboard.
- 3) Boxes.
- 4) Plastic sheet and film.
- 5) Polystyrene packaging.
- 6) Wood crates.
- 7) Wood pallets.
- 8) Plastic pails.

m. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:

- 1) Paper.
- 2) Aluminum cans.
- 3) Glass containers.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
1. Comply with operation, termination, and removal requirements in Section 01 50 00 "Temporary Facilities and Controls."
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
1. Distribute waste management plan to everyone concerned within three days of submittal return.
 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
 2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.
- E. Waste Management in Historic Zones or Areas: Transportation equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, by 12 inches (300 mm) or more.

3.2 SALVAGING DEMOLITION WASTE

- A. Comply with requirements in Section 02 41 19 "Selective Demolition" for salvaging demolition waste.
- B. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 - 3. Store items in a secure area until installation.
 - 4. Protect items from damage during transport and storage.
 - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- C. Salvaged Items for Sale and Donation: Not permitted on Project site.
- D. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area designated by Owner.
 - 5. Protect items from damage during transport and storage.
- E. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- F. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- G. Plumbing Fixtures: Separate by type and size.
- H. Lighting Fixtures: Separate lamps by type and protect from breakage.
- I. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner unless otherwise decided contractually.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.4 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Grind asphalt to maximum 1-1/2-inch (38-mm) size.
 1. Crush asphaltic concrete paving and screen to comply with requirements in Section 31 20 00 "Earth Moving" for use as general fill.
- B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 1. Pulverize concrete to maximum 1-1/2-inch (38-mm) size.
 2. Crush concrete and screen to comply with requirements in Section 31 20 00 "Earth Moving" for use as satisfactory soil for fill or subbase.
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 1. Pulverize masonry to maximum 3/4-inch (19-mm) size.
 2. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- F. Metals: Separate metals by type.
 1. Structural Steel: Stack members according to size, type of member, and length.
 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
- H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

- J. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.
- K. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
 - 1. Store clean, dry carpet and pad in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- L. Carpet Tile: Remove debris, trash, and adhesive.
 - 1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- M. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.
- N. Conduit: Reduce conduit to straight lengths and store by material and size.
- O. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.5 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.
 - 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 - 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- B. Wood Materials:
 - 1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
 - 2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
 - a. Comply with requirements in Section 32 93 00 "Plants" for use of clean sawdust as organic mulch.
- C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.
 - 1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
 - a. Comply with requirements in Section 32 93 00 "Plants" for use of clean ground gypsum board as inorganic soil amendment.
- D. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner's property.
- C. Burning: Do not burn waste materials.
- D. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

3.7 FORMS

- A. Form CWM-1 for construction waste identification.
- B. Form CWM-2 for demolition waste identification.
- C. Form CWM-3 for construction waste reduction work plan.
- D. Form CWM-4 for demolition waste reduction work plan.
- E. Form CWM-5 for cost/revenue analysis of construction waste reduction work plan.
- F. Form CWM-6 for cost/revenue analysis of demolition waste reduction work plan.
- G. Form CWM-7 for construction waste reduction progress report.
- H. Form CWM-8 for demolition waste reduction progress report.

END OF SECTION 01 74 19

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Repair of the Work.
- B. Related Requirements:
 - 1. Section 01 78 23 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 2. Section 01 78 39 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 3. Section 01 79 00 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at final completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Architect's and Owner's signature for receipt of submittals.
 - 5. Submit testing, adjusting, and balancing records.
 - 6. Submit sustainable design submittals not previously submitted.
 - 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Advise Owner of pending insurance changeover requirements.
 - 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 3. Complete startup and testing of systems and equipment.
 - 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 - 6. Advise Owner of changeover in utility services.
 - 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.

8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements.
 10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for final completion.

1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
1. Submit a final Application for Payment according to Section 01 29 00 "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
 5. Submit final completion photographic documentation.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:

- a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Page number.
4. Submit list of incomplete items in one of the following formats:
- a. PDF or EXCEL electronic file. Architect will return annotated file.
 - b. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 1. Submit on digital media acceptable to Architect.
- E. Warranties also to be submitted in Paper Form:
 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- F. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - 1) Clean HVAC system in compliance with NADCA ACR. Provide written report on completion of cleaning.

- p. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - q. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 01 50 00 "Temporary Facilities and Controls." Prepare written report.
- D. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 50 00 "Temporary Facilities and Controls" and Section 01 74 19 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 01 77 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Section 01 91 13 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:

1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.
 2. Also, Submit three paper copies. Architect will return two copies.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.
1. Correct or revise each manual to comply with Architect's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.
- E. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Also, submit manuals in the form of hard-copy, bound and labeled volumes.
1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components

- of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
 4. Supplementary Text: Prepared on 8-1/2-by-11-inch (215-by-280-mm) white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 1. Title page.
 2. Table of contents.
 3. Manual contents.
- B. Title Page: Include the following information:
 1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Construction Manager.
 7. Name and contact information for Architect.
 8. Name and contact information for Commissioning Authority.
 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to

ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.8 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

1.9 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.

- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of maintenance manuals.

1.11 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.

2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Section 01 73 00 "Execution" for final property survey.
 - 2. Section 01 77 00 "Closeout Procedures" for general closeout procedures.
 - 3. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set of marked-up record prints.
 - 2. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit record digital data files and one set of plots.
 - 2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit PDF electronic files of scanned record prints and three set of prints.
 - 2) Print each drawing, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit one paper copy and annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

- C. Record Product Data: Submit one paper copy and annotated PDF electronic files and directories of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit one paper copy and annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report weekly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 - 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Architect for resolution.
 4. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 01 31 00 "Project Management and Coordination" for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.
- C. 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 annotated PDF electronic file and 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 annotated PDF electronic file and 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 PDF electronic file and 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

PART 3 - EXECUTION

END OF SECTION 01 78 39

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
 - 2. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Attendance Record: For each training module, submit list of participants and length of instruction time.
- C. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer, if any.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date of video recording.

2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
4. At completion of training, submit complete training manual(s) for Owner's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 01 78 23 "Operation and Maintenance Data."

1.5 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 1. Inspect and discuss locations and other facilities required for instruction.
 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 3. Review required content of instruction.
 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.7 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Systems and equipment operation manuals.
 - c. Systems and equipment maintenance manuals.
 - d. Product maintenance manuals.
 - e. Project Record Documents.
 - f. Identification systems.
 - g. Warranties and bonds.
 - h. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.

- l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning.
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

1.8 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

1.9 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.

2. Owner will furnish an instructor to describe Owner's operational philosophy.
 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
1. Schedule training with Owner, through Architect, with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test.
- F. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.10 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD modewith vibration reduction technology.
1. Submit video recordings on CD-ROM or thumb drive and by uploading to web-based Project software site.
 2. File Hierarchy: Organize folder structure and file locations according to Project Manual table of contents. Provide complete screen-based menu.
 3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
 4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged according to Project Manual table of contents:
 - a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. Email address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
1. Film training session(s) in segments not to exceed 15 minutes.

- a. Produce segments to present a single significant piece of equipment per segment.
 - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
 - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
1. Furnish additional portable lighting as required.
- E. Narration: Describe scenes on video recording by dubbing audio narration off-site after video recording is recorded. Include description of items being viewed.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 01 79 00

SECTION 01 81 13.13 - SUSTAINABLE DESIGN REQUIREMENTS - LEED 2009 FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED certification based on USGBC's "LEED 2009 for New Construction & Major Renovations."
 - 1. Other LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
 - 2. A copy of LEED Project checklist is attached at the end of this Section for information only.
 - a. Some LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.

1.3 DEFINITIONS

- A. LEED: USGBC's "LEED 2009 for New Construction & Major Renovations."
 - 1. Definitions that are a part of "LEED 2009 for New Construction and Major Renovations" apply to this Section.
- B. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
- C. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.
- D. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

1. "Postconsumer" material is waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
2. "Preconsumer" material is material diverted from the waste stream during the manufacturing process. Reutilization of materials (such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it) is excluded.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Review LEED requirements and action plans for complying with requirements.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Respond to questions and requests from Architect and USGBC about LEED prerequisites and credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until USGBC has made its determination on Project's LEED certification application. Document responses as informational submittals.
- B. Submit documentation to USGBC and respond to questions and requests from USGBC about LEED prerequisites and credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until USGBC has made its determination on Project's LEED certification application.
 1. Document correspondence with USGBC as informational submittals.

1.6 ACTION SUBMITTALS

- A. General: Submit additional sustainable design submittals required by other Specification Sections.
- B. Sustainable design submittals are in addition to other submittals.
 1. If submitted item is identical to that submitted to comply with other requirements, include an additional copy with other submittal as a record copy of compliance with indicated LEED requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable design submittal."
- C. Sustainable Design Documentation Submittals:
 1. Credit EA 5: Product Data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over time.
 2. Credit MR 2: Comply with Section 01 74 19 "Construction Waste Management and Disposal."
 3. Credit MR 4: Product Data for recycled content indicating postconsumer and preconsumer recycled content and cost.
 4. Credit MR 5: Product Data for regional materials indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

5. Credit MR 7: Product Data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
6. Credit IEQ 3.1:
 - a. Construction indoor-air-quality management plan.
 - b. Product Data for temporary filtration media.
 - c. Product Data for filtration media used during occupancy.
 - d. Construction Documentation: Six photographs at each of three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
7. Credit IEQ 3.2:
 - a. Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
 - b. Product Data for filtration media used during flush-out and during occupancy.
 - c. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.
8. Credit IEQ 4.1: Product Data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
9. Credit IEQ 4.2: Product Data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.
10. Credit IEQ 4.4: Product Data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For LEED coordinator.
- B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
 1. Furniture.
 2. Plumbing.
 3. Mechanical.
 4. Electrical.
 5. Specialty items such as elevators and equipment.
 6. Wood-based construction materials.
- C. Sustainable Design Action Plans: Provide preliminary submittals within 14 days of date established for the Notice of Award indicating how the following requirements will be met:
 1. Credit MR 2: Waste management plan complying with Section 01 74 19 "Construction Waste Management and Disposal."
 2. Credit MR 4: List of proposed materials with recycled content. Indicate cost, postconsumer recycled content, and preconsumer recycled content for each product having recycled content.

3. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
 4. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
 5. Credit IEQ 3.1: Construction indoor-air-quality management plan.
- D. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with sustainable design action plans.

1.8 QUALITY ASSURANCE

- A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to these LEED credits, Contractor shall provide additional materials and procedures necessary to obtain LEED credits indicated.

2.2 RECYCLED CONTENT OF MATERIALS

- A. Credit MR 4: Building materials shall have recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content for Project constitutes a minimum of 10 or 20 percent (Verify percentage with Owner) of cost of materials used for Project.
1. Cost of postconsumer recycled content plus one-half of preconsumer recycled content of an item shall be determined by dividing weight of postconsumer recycled content plus one-half of preconsumer recycled content in the item by total weight of the item and multiplying by cost of the item.
 2. Do not include furniture, plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.3 REGIONAL MATERIALS

- A. Credit MR 5: Not less than 10 or 20 percent (Verify percentage with Owner) of building materials (by cost) shall be regional materials.

2.4 CERTIFIED WOOD

- A. Credit MR 7: Not less than 50 percent (by cost) of wood-based materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
 - a. Rough carpentry.
 - b. Miscellaneous carpentry.
 - c. Heavy timber construction.
 - d. Wood decking.
 - e. Metal-plate-connected wood trusses.
 - f. Structural glued-laminated timber.
 - g. Finish carpentry.
 - h. Architectural woodwork.
 - i. Wood paneling.
 - j. Wood veneer wall covering.
 - k. Wood flooring.
 - l. Wood lockers.
 - m. Wood cabinets.
 - n. Furniture.

2.5 LOW-EMITTING MATERIALS

- A. Credit IEQ 4.1: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Wood Glues: 30 g/L.
2. Metal-to-Metal Adhesives: 30 g/L.
3. Adhesives for Porous Materials (except Wood): 50 g/L.
4. Subfloor Adhesives: 50 g/L.
5. Plastic Foam Adhesives: 50 g/L.
6. Carpet Adhesives: 50 g/L.
7. Carpet Pad Adhesives: 50 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesive: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesive: 100 g/L.
18. Structural Wood Member Adhesive: 140 g/L.
19. Single-Ply Roof Membrane Adhesive: 250 g/L.
20. 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.
21. Top and Trim Adhesive: 250 g/L.
22. Plastic Cement Welding Compounds: 250 g/L.
23. ABS Welding Compounds: 325 g/L.
24. CPVC Welding Compounds: 490 g/L.
25. PVC Welding Compounds: 510 g/L.
26. Adhesive Primer for Plastic: 550 g/L.
27. Sheet-Applied Rubber Lining Adhesive: 850 g/L.
28. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
29. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.

30. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
 31. Other Adhesives: 250 g/L.
 32. Architectural Sealants: 250 g/L.
 33. Nonmembrane Roof Sealants: 300 g/L.
 34. Single-Ply Roof Membrane Sealants: 450 g/L.
 35. Other Sealants: 420 g/L.
 36. Sealant Primers for Nonporous Substrates: 250 g/L.
 37. Sealant Primers for Porous Substrates: 775 g/L.
 38. Modified Bituminous Sealant Primers: 500 g/L.
 39. Other Sealant Primers: 750 g/L.
- B. Credit IEQ 4.2: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
1. Flat Paints and Coatings: VOC not more than 50 g/L.
 2. Nonflat Paints and Coatings: VOC not more than 150 g/L.
 3. Dry-Fog Coatings: VOC not more than 400 g/L.
 4. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 6. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
 7. Pretreatment Wash Primers: VOC not more than 420 g/L.
 8. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 9. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
 10. Floor Coatings: VOC not more than 100 g/L.
 11. Shellacs, Clear: VOC not more than 730 g/L.
 12. Shellacs, Pigmented: VOC not more than 550 g/L.
 13. Stains: VOC not more than 250 g/L.
- C. Credit IEQ 4.4: Composite wood, agrifiber products, and adhesives shall not contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 NONSMOKING BUILDING

- A. Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.

3.2 REFRIGERANT AND CLEAN-AGENT FIRE-EXTINGUISHING-AGENT REMOVAL

- A. Prerequisite EA 3: Remove CFC-based refrigerants according to Section 02 41 19 "Selective Demolition" from existing HVAC&R equipment indicated to remain and replace with refrigerants that are not CFC based. Replace or adjust existing equipment to accommodate new refrigerant as described in HVAC Sections.
- B. Credit EA 4: Remove clean-agent fire-extinguishing agents that contain HCFCs or halons according to Section 02 41 19 "Selective Demolition" and replace with agent that does not contain HCFCs or halons. See Section 21 22 00 "Clean-Agent Fire-Extinguishing Systems" for additional requirements.

3.3 MEASUREMENT AND VERIFICATION

- A. Credit EA 5: Implement measurement and verification plan consistent with Option B: Energy Conservation Measure Isolation and/or Option D: Calibrated Simulation, Savings Estimation Method 2 in the EVO's International Performance Measurement and Verification Protocol (IPMVP), "Volume III: Concepts and Options for Determining Energy Savings in New Construction."

3.4 CONSTRUCTION WASTE MANAGEMENT

- A. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."

3.5 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

- A. Credit IEQ 3.1: Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
 - 1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 01 50 00 "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
 - 2. Replace air filters immediately prior to occupancy.

3.6 INDOOR-AIR-QUALITY ASSESSMENT

- A. Flush-Out:
 - 1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14,000 cu. ft. (4 300 000 L) of outdoor air per sq. ft. (sq. m) of floor area while maintaining an internal temperature of at least 60 deg F (16 deg C) and a relative humidity no higher than 60 percent.
 - 2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. (1 070 000 L) of outdoor air per sq. ft. (sq. m) of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. (1.52 L/s per sq. m) of outside air or the design minimum outside air rate determined in Prerequisite IEQ 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14,000 cu. ft./sq. ft. (4 300 000 L/sq. m) of outside air has been delivered to the space.
- B. Air-Quality Testing: Engage testing agency to perform the following:
 - 1. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in USGBC's "Green Building Design and Construction Reference Guide."
 - 2. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
 - a. Formaldehyde: 27 ppb.

- b. Particulates (PM10): 50 mcg/cu. m.
 - c. Total Volatile Organic Compounds (TVOC): 500 mcg/cu. m.
 - d. 4-Phenylcyclohexene (4-PH): 6.5 mcg/cu. m.
 - e. Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
3. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.
4. Air-sample testing shall be conducted as follows:
 - a. All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside airflow rate for the occupied mode throughout the duration of the air testing.
 - b. Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
 - c. Number of sampling locations varies depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. (2300 sq. m) or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
 - d. Air samples shall be collected between 3 and 6 feet (0.9 and 1.8 m) from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION 01 81 13.13

SECTION 01 81 13.19 - SUSTAINABLE DESIGN REQUIREMENTS - LEED 2009 FOR CORE AND SHELL DEVELOPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED certification based on USGBC's "LEED 2009 for Core and Shell Development."
 - 1. Other LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
 - 2. A copy of the LEED Project checklist is attached at the end of this Section for information only.
 - a. Some LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.

1.3 DEFINITIONS

- A. LEED: USGBC's "LEED 2009 for Core and Shell Development."
 - 1. Definitions that are a part of "LEED 2009 for Core and Shell Development" apply to this Section.
- B. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
- C. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.
- D. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
2. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Review LEED requirements and action plans for meeting requirements.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Respond to questions and requests from Architect and the USGBC about LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until the USGBC has made its determination on the project's LEED certification application. Document responses as informational submittals.
- B. Submit documentation to USGBC and respond to questions and requests from USGBC about LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until the USGBC has made its determination on the project's LEED certification application.
 1. Document correspondence with USGBC as informational submittals.

1.6 ACTION SUBMITTALS

- A. General: Submit additional sustainable design submittals required by other Specification Sections.
- B. Sustainable design submittals are in addition to other submittals.
 1. If submitted item is identical to that submitted to comply with other requirements, include an additional copy with other submittal as a record copy of compliance with indicated LEED requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable design submittal."
- C. Sustainable Design Documentation Submittals:
 1. Credit EA 5.1 and 5.2: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over time.
 2. Credit MR 2: Comply with Section 01 74 19 "Construction Waste Management and Disposal."
 3. Credit MR 4: Product data for recycled content indicating post-consumer and pre-consumer recycled content and cost.
 4. Credit MR 5: Product data for regional materials indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

5. Credit MR 6: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
6. Credit IEQ 3:
 - a. Construction indoor-air-quality (IAQ) management plan.
 - b. Product data for temporary filtration media.
 - c. Product data for filtration media used during occupancy.
 - d. Construction Documentation: Six photographs at each of three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.
7. Credit IEQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
8. Credit IEQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.
9. Credit IEQ 4.4: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea formaldehyde resin.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For LEED coordinator.
- B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
 1. Plumbing.
 2. Mechanical.
 3. Electrical.
 4. Specialty items such as elevators and equipment.
 5. Wood-based construction materials.
- C. Sustainable Design Action Plans: Provide preliminary submittals within 14 days of date established for the Notice of Award indicating how the following requirements will be met:
 1. Credit MR 2: Waste management plan complying with Section 01 74 19 "Construction Waste Management and Disposal."
 2. Credit MR 4: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
 3. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
 4. Credit MR 6: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
 5. Credit IEQ 3: Construction IAQ management plan.
- D. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with sustainable design action plans.

1.8 QUALITY ASSURANCE

- A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to these LEED credits, the Contractor shall provide additional materials and procedures necessary to obtain LEED credits indicated.

2.2 RECYCLED CONTENT OF MATERIALS

- A. Credit MR 4: Building materials shall have recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content for Project constitutes a minimum of 10 or 20 percent (Verify percentage with Owner) of cost of materials used for Project.
 - 1. Cost of post-consumer recycled content plus one-half of pre-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content plus one-half of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
 - 2. Do not include furniture, plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.3 REGIONAL MATERIALS

- A. Credit MR 5: Not less than 10 or 20 percent (Verify percentage with Owner) of building materials (by cost) shall be regional materials.

2.4 CERTIFIED WOOD

- A. Credit MR 6: Not less than 50 percent (by cost) of wood-based materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
 - 1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
 - a. Rough carpentry.
 - b. Miscellaneous carpentry.
 - c. Heavy timber construction.
 - d. Wood decking.
 - e. Metal-plate-connected wood trusses.
 - f. Structural glued-laminated timber.
 - g. Finish carpentry.
 - h. Architectural woodwork.
 - i. Wood paneling.

- j. Wood veneer wall covering.
- k. Wood flooring.
- l. Wood lockers.
- m. Wood cabinets.

2.5 LOW-EMITTING MATERIALS

- A. Credit IEQ 4.1: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Wood Glues: 30 g/L.
2. Metal-to-Metal Adhesives: 30 g/L.
3. Adhesives for Porous Materials (Except Wood): 50 g/L.
4. Subfloor Adhesives: 50 g/L.
5. Plastic Foam Adhesives: 50 g/L.
6. Carpet Adhesives: 50 g/L.
7. Carpet Pad Adhesives: 50 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesives: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesives: 100 g/L.
18. Structural Wood Member Adhesives: 140 g/L.
19. Single-Ply Roof Membrane Adhesives: 250 g/L.
20. Special-Purpose Contact Adhesives (contact adhesives that are 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.
21. Top and Trim Adhesives: 250 g/L.
22. Plastic Cement Welding Compounds: 250 g/L.
23. ABS Welding Compounds: 325 g/L.
24. CPVC Welding Compounds: 490 g/L.
25. PVC Welding Compounds: 510 g/L.
26. Adhesive Primers for Plastics: 550 g/L.
27. Sheet-Applied Rubber Lining Adhesives: 850 g/L.
28. Aerosol Adhesives, General-Purpose Mist Spray: 65 percent by weight.
29. Aerosol Adhesives, General-Purpose Web Spray: 55 percent by weight.
30. Special-Purpose Aerosol Adhesives (All Types): 70 percent by weight.
31. Other Adhesives: 250 g/L.
32. Architectural Sealants: 250 g/L.
33. Nonmembrane Roof Sealants: 300 g/L.
34. Single-Ply Roof Membrane Sealants: 450 g/L.
35. Other Sealants: 420 g/L.
36. Sealant Primers for Nonporous Substrates: 250 g/L.
37. Sealant Primers for Porous Substrates: 775 g/L.
38. Modified Bituminous Sealant Primers: 500 g/L.
39. Other Sealant Primers: 750 g/L.

- B. Credit IEQ 4.2: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
1. Flat Paints and Coatings: VOC not more than 50 g/L.
 2. Nonflat Paints and Coatings: VOC not more than 150 g/L.
 3. Dry-Fog Coatings: VOC not more than 400 g/L.
 4. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 6. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
 7. Pretreatment Wash Primers: VOC not more than 420 g/L.
 8. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 9. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
 10. Floor Coatings: VOC not more than 100 g/L.
 11. Shellacs, Clear: VOC not more than 730 g/L.
 12. Shellacs, Pigmented: VOC not more than 550 g/L.
 13. Stains: VOC not more than 250 g/L.
- C. Credit IEQ 4.4: Composite wood, agrifiber products, and adhesives shall not contain urea formaldehyde resin.

PART 3 - EXECUTION

3.1 NONSMOKING BUILDING

- A. Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.

3.2 REFRIGERANT AND CLEAN-AGENT FIRE-EXTINGUISHING-AGENT REMOVAL

- A. Prerequisite EA 3: Remove chlorofluorocarbon (CFC)-based refrigerants according to Section 02 41 19 "Selective Demolition" from existing HVAC&R equipment indicated to remain and replace with refrigerants that are not CFC based. Replace or adjust existing equipment to accommodate new refrigerant as described in HVAC Sections.
- B. Credit EA 4: Remove clean-agent fire-extinguishing agents that contain hydrochlorofluorocarbons (HCFCs) or halons according to Section 02 41 19 "Selective Demolition" and replace with agent that does not contain HCFCs or halons. See Section 21 22 00 "Clean-Agent Fire-Extinguishing Systems" for additional requirements.

3.3 MEASUREMENT AND VERIFICATION

- A. Credit EA 5.1 and 5.2: Implement measurement and verification plan consistent with Option B: Energy Conservation Measure Isolation and/or Option D: Calibrated Simulation, Savings Estimation Method 2 in the EVO's "International Performance Measurement and Verification Protocol, Volume III: Concepts and Options for Determining Energy Savings in New Construction."

3.4 CONSTRUCTION WASTE MANAGEMENT

- A. Credit MR 2: Comply with Section 01 74 19 "Construction Waste Management and Disposal."

3.5 CONSTRUCTION IAQ MANAGEMENT

- A. Credit IEQ 3: Comply with SMACNA's "IAQ Guideline for Occupied Buildings under Construction."
 - 1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 01 50 00 "Temporary Facilities and Controls," install MERV 8 filter media at each return-air inlet for the air-handling system used during construction.
 - 2. Replace air filters immediately prior to occupancy.

END OF SECTION 01 81 13.19

SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. The Owner's Project Requirements (OPR) and the A/E team's Basis of Design (BoD) are included by reference for information only.
- C. ASHRAE Standard 90.1-2010
- D. ASHRAE Guideline 0 - 2005 – The Commissioning Process
- E. ASHRAE Guideline 1.1-2007 - HVAC&R Technical Requirements for The Commissioning Process
- F. ASHRAE Standard 202-2013 – Commissioning Process for Buildings and Systems

1.2 SUMMARY

- A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.
- B. Commissioning is systematic processes to provide documented confirmation that building systems perform according to the criteria set forth in the design intent and satisfy the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. The Commissioning process shall comply with ASHRAE Guidelines 0-2005 and 1.1-2007 and ASHRAE Standard 202-2013.
- C. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - 2. Verify and document proper performance of equipment and systems.
 - 3. Verify that O&M documentation left on site is complete.
 - 4. Verify that the Owner's operating personnel are adequately trained.

- D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.
- E. Abbreviations. The following are common abbreviations used in the Specifications and in the Commissioning Plan. Definitions are found in Section 1.3.

A/E-	Architect and design engineers	FMD-	Facility Management Dept.
BECC-	Bldg. Envelope Cx Consultant	GC-	General / Coord. Contractor
CC-	Controls contractor	HC-	Heating Contractor
CVC-	Component Verif. Checklist	OR-	Owner's Representative
Cx-	Commissioning	PM-	Project manager (of the Owner)
CxA-	Commissioning authority	RFI-	Requests for Information
Cx Plan-	Commissioning Plan document	Subs-	Subcontractors to General
EC-	Electrical contractor	TAB-	Test and balance contractor
EOR-	Engineer-of-Record	UIS-	Univ. of Illinois - Springfield
FPT-	Functional performance test	VC-	Ventilation Contractor (VC)

F. Related Sections:

1. Division 22 - "Commissioning of Plumbing Systems" for commissioning process activities for plumbing systems, assemblies, equipment, and components.
2. Division 23 - "Commissioning of HVAC Systems" for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.
3. Division 26 - "Commissioning of Electrical Systems" for commissioning process activities for electrical systems, assemblies, equipment, and components.

1.3 DEFINITIONS

- A. Acceptance Phase. Phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occurs.
- B. Approval. Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.
- C. Architect/Engineer (A/E): The prime consultant (architect) and sub-consultants who comprise the design team, generally the HVAC mechanical designer/engineer, the plumbing designer/engineer, and the electrical designer/engineer.
- D. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR 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.
- E. Component Verification Checklist (CVC): A list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the CxA to the Sub. Verification checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). Verification checklists augment and are combined with the manufacturer's start-up checklist. Contractors typically perform some, if not many, of

the verification checklist items a commissioning authority will recommend as part of their own start-up process. However, few contractors document in writing the execution of these checklist items. Therefore, for most equipment, the contractors execute the checklists on their own. The commissioning authority requires that the procedures be documented in writing, and will only witness (or back check) a representative number of the completed verification checklists, except for larger or more critical pieces of equipment.

- F. CxA: Commissioning Authority. An independent agent, not otherwise associated with the A/E team members or the GC, hired by the Owner. The CxA directs and coordinates the day-to-day commissioning activities. The CxA does not take an oversight role like the GC. The CxA is part of the project team or shall report directly to the Owner.
- G. Cx Plan: Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process
- H. Datalogging: Monitoring flows, currents, status, pressures, etc. of equipment using stand-alone dataloggers separate from the control system.
- I. Deferred Functional Tests: FTs that are performed later, (possibly after substantial completion), due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed. Typically, the Owner must consent to the deferred testing.
- J. Deficiency : A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the design intent)
- K. Design Intent: A dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases.
- L. Design Narrative or Design Documentation: Sections of either the Design Intent or Basis of Design.
- M. Factory Testing: Testing of equipment on-site or at the factory by factory personnel with an Owner's representative present.
- N. Functional Performance Test (FPT) or (FT): Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. FTs are performed after prefunctional checklists and start-up are complete. Test results are issued immediately after completion; often accompanied by an interim Cx report.
- O. General / Coordinating Contractor (GC): Construction firm and/or individual responsible for a portion of the general work and responsible for coordination of other discipline contractors,

including plumbing, mechanical, electrical, fire protection and controls.

- P. Indirect Indicators: Indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed
- Q. Manual Test: Using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- R. Master Issues Log: An ongoing log maintained by the Commissioning Authority that describes commissioning issues and commissioning observations that are identified throughout the project's Cx process. These observations and issues include, but are not limited to, those that are variance with the Contract Documents, the OPR, the Design Intent and/or that compromise the Owner's ability to adequately service and maintain the equipment and systems.
- S. Monitoring: The recording of parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of control systems.
- T. Non-Compliance: See Deficiency.
- U. Non-Conformance: See Deficiency.
- V. Over-written Value: Writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50F to 75F to verify economizer operation). See also "Simulated Signal."
- W. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- X. Sampling: Functionally testing only a fraction of the total number of identical or near identical pieces of equipment.
- Y. Seasonal Performance Tests: FT that are deferred until the system(s) will experience conditions closer to their design conditions.
- Z. Simulated Condition: Condition that is created for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).
- AA. Simulated Signal: Disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.
- BB. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- CC. Startup: The initial starting or activating of dynamic equipment, including executing prefunctional checklists.
- DD. Subs: The subcontractors to the GC who provide and install building components and systems.
- EE. Test Procedures: The step-by-step process which must be executed to fulfill the test requirements. The test procedures are developed by the CxA.
- FF. Test Requirements: Requirements specifying what modes and functions, etc. shall be tested.

The test requirements are not the detailed test procedures. The test requirements are specified in the Contract Documents

GG. Trending: Monitoring using the building control system.

HH. Vendor: Supplier of equipment.

II. Warranty Period: Warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

1.4 COORDINATION

- A. Commissioning Team. The members of the commissioning team consist of the Commissioning authority (CxA), the Owner's Representative (OR), the designated representative of the owner's General / Coordinating Construction firm (GC), the architect and design engineers (particularly the mechanical engineer), the Heating Contractor (HC), the Ventilating Contractor (VC), the Plumbing Contractor (PC), the Electrical Contractor (EC), the TAB representative, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment. If known, the Owner's building or plant operator/engineer is also a member of the commissioning team.
- B. Management. The CxA is hired by the Owner directly. The CxA directs and coordinates the commissioning activities and the reports to the OR. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
- C. Scheduling. The CxA will work with the GC according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the GC for scheduling commissioning activities. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- D. The CxA will provide the initial schedule of primary commissioning events at the commissioning scoping meeting. The Commissioning Plan—Construction Phase provides a format for this schedule. As construction progresses more detailed schedules are developed by the CxA. The Commissioning Plan also provides a format for detailed schedules and reports.

1.5 COMMISSIONING PROCESS

- A. Commissioning Plan. The Commissioning Plan, provided as part of the bid documents, is binding on the Contractor. The commissioning plan provides guidance in the execution of the commissioning process. Just after the initial commissioning scoping meeting the CxA will update the plan which is then considered the "final" plan, though it will continue to evolve and expand as the project progresses. The Specifications will take precedence over the Commissioning Plan.
- B. Commissioning Process. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur. A further explanation of the entire Cx Process is included in the project's Commissioning Plan (CxPlan).
 - 1. Commissioning during construction begins with a kick-off (scoping) meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the CxA with

- necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
3. Contractor submittals / shop drawings for commissioned equipment and systems are submitted to the CxA for review, to verify compliance with the OPR and BoD.
 4. Equipment documentation is submitted to the CxA during normal submittals, including detailed start-up procedures.
 5. The CxA works with the Subs in developing startup plans and startup documentation formats, including providing the Subs with verification checklists to be completed, during the startup process.
 6. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with verification checklists being completed before functional testing.
 7. The Subs, under their own direction, execute and document the verification checklists and perform startup and initial checkout. The CxA documents that the checklists and startup were completed according to the approved plans. This may include the CxA witnessing start-up of selected equipment.
 8. The CxA develops specific equipment and system functional performance test procedures. The Subs review the procedures.
 9. The procedures are executed by the Subs, under the direction of, and documented by the CxA.
 10. Items of non-compliance in material, installation or setup are corrected at the Sub's expense and the system retested.
 11. The CxA reviews the O&M documentation for completeness.
 12. Commissioning is completed before Substantial Completion, unless deferred testing is required.
 13. The CxA reviews, pre-approves and coordinates the training provided by the Subs and verifies that it was completed.
 14. Deferred testing is conducted, as specified or required.

C. Cloud-based Web Application Software

1. For this project, the Cx Authority will be utilizing a cloud-based web application for managing the commissioning documentation associated with the project. A dedicated project site will be established and this web application will provide real time data and a single interface for all project team members to share information and collaborate effectively.
2. Commissioning documentation will be maintained on this site and secure access will be provided to all team members. Cx documentation will be maintained in an electronic format, with automatic synchronization with the cloud as it is updated. However, provisions will be provided to create PDF versions of select Cx files for printing.
3. Team members will be notified of updates to the site through e-mails on a regular basis (typically daily). Discrete commissioning files will not be e-mailed to the team. This system will require contractors and subcontractors to monitor Cx activities and documentation through the site, and will allow the use of tablet (or laptop) PCs when completing checklists and addressing issues in the field, if desired. Tablets and/or laptop PCs will be the responsibility of the individual team members. Alternatively, contractors may print paper versions of checklists and forms for completion in the field. If paper forms are utilized, it will be the responsibility of the contractor to accurately update the system with the information gathered in the field on paper forms in a timely manner. Requirements for same (compatible operating systems and browsers) will be provided by the Cx Authority.
4. The Cx Authority will provide initial instruction on the use of this web application and answer questions at a Cx kick-off meeting. All contractors and subcontractors will be expected to have designated representatives from their firms available for training.

1.6 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, the General / Coordinating Contractor (GC), including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members Appointed by Owner:
 - 1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
 - 2. Representatives of the facility user and operation and maintenance personnel.
 - 3. The Owners Representative.
 - 4. Architect and engineering design professionals.

1.7 OWNER'S AND OWNER'S REPRESENTATIVE'S RESPONSIBILITIES

- A. The OPR has been developed through discussions between the CxA and the Owner. After final approval, the Owner will provide the OPR documentation to the A/E and the GC for information and use.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
- C. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.
- D. Follow the Commissioning Plan.
- E. Attend commissioning scoping meetings and additional meetings as necessary.
- F. The Owner's Representative OR shall represent the Owner during the commissioning process as follows:
 - 1. Manage the contract of the A/E, CxA, GC.
 - 2. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions according to the Commissioning Plan – Construction Phase.
 - 3. Provide final approval for the completion of the commissioning work.
 - 4. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.
 - 5. Follow the Commissioning Plan.
 - 6. Attend commissioning scoping meetings and additional meetings as necessary.

1.8 ARCHITECT/ENGINEERS (AE) RESPONSIBILITIES

- A. The AE shall comply with the fullest extent with the University of Illinois – Springfield (UIS) Design Guidelines in regards to Design for Maintainability & Design for Reliability. The A/E shall participate in and perform commissioning process activities including, but not limited to, the following:
 - 1. Attend the commissioning scoping meeting and selected commissioning team meetings.

2. Perform normal submittal review of the following documents; as-built drawing, O&M manual, etc., as contracted. Review and approve final as-built design intent documentation for inclusion in the O&M manuals. Review and approve the O&M manuals issued by the GC. Issue the approved O&M manuals to the CxA.
3. The Engineer-of-Record will review the Control subcontractor's HVAC controls submittal, including the final sequence of operations. Provide any additional design narrative and sequence documentation requested by the CxA. The designers shall assist (along with the GC) in 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.
4. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
5. Coordinate resolution of design non-conformance and design deficiencies identified during construction, acceptance and warranty-period commissioning. Participate in the resolution of non-compliance, non-conformance and construction deficiencies identified during commissioning.

1.9 GENERAL / COORDINATING CONTRACTOR'S (GC) RESPONSIBILITIES

- A. The GC shall participate in and perform commissioning process activities including, but not limited to the following:
1. Facilitate the coordination of the commissioning work by the CxA. The GC shall ensure that commissioning activities are being scheduled into the master project schedule.
 2. Review and acknowledge acceptance of the final Commissioning Plan—Construction Phase.
 3. Attend a commissioning kick-off (scoping) meeting and other commissioning team meetings.
 4. Issue Subcontractor submittals for A/E approval and CxA review.
 5. Furnish a copy of all construction documents, addenda, requests for information, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
 6. Issue O & M manuals to A/E, CxA per requirements of Division 1 specifications.
 7. Review and approve the functional performance test procedures submitted by the CxA, prior to testing.
 8. Review commissioning progress and deficiency reports.
 9. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
 10. Coordinate with the CxA for resolution of issues recorded in the CxA Issues Log.
 11. Review and accept construction verification checklists provided by the CxA.
 12. Complete paper or electronic construction verification checklists as work is completed and provide to the CxA on a weekly basis. Complete commissioning process test procedures.
 13. Include the cost of for coordinating commissioning with the CxA in the total contract price.
 14. Per specification section 01 79 00 Demonstration and Training, coordinate with CxA to develop a training plan for Owner's personnel, including: curricula, qualifications of trainers, schedule for training, length of training, etc.
 15. Execute seasonal or deferred functional performance testing witnessed by the CxA to facilitate the Cx process.
 16. Provide a list of final settings, setpoints, ranges, schedules, and / or trend logs required by the CxA.
 17. Follow the Commissioning Plan throughout the entire project duration.
 18. Attend commissioning scoping meetings and additional meetings as necessary.
 19. From the red-line drawings, edit and update one-line diagrams developed as part of the

design narrative documentation and those provided by the vendor as shop drawings for the BAS, chilled and hot water systems, domestic HW water system, supply & return air systems, exhaust systems and emergency power system.

1.10 SUB CONTRACTOR'S RESPONSIBILITIES

- A. The GC shall assign representatives from the various discipline subcontractors, with expertise and authority to act on its behalf, and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
 2. Complete appropriate verification checklists and pre-functional start-up checklists and forms, as required.
 3. Assist in equipment testing per agreements with GC.
 4. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CxA.
 5. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
 6. Review test procedures for equipment installed by factory representatives.
 7. Follow the Commissioning Plan.
 8. Attend commissioning scoping meetings and additional meetings, as necessary.

1.11 EQUIPMENT SUPPLIERS RESPONSIBILITIES

- A. The equipment suppliers shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
 2. Assist in equipment testing per agreements with Subs.
 3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the GC, except for stand-alone datalogging equipment that may be used by the CxA.
 4. Through the contractors they supply products to, analyze specified products and verify that the designer has specified the newest most updated equipment reasonable for this project's scope and budget.
 5. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
 6. Review test procedures for equipment installed by factory representatives.
 7. Follow the Commissioning Plan.
 8. Attend commissioning scoping meetings and additional meetings as necessary.

1.12 CxA'S RESPONSIBILITIES

- A. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving, non-conformance or deficiencies, but ultimately that responsibility

resides with the GC and the A/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. The GC and associated discipline subcontractors will provide all tools or the use of tools to start; check-out; test, adjust and balance (TAB); and functionally test equipment and systems; except for specified testing with portable data-loggers, which shall be supplied and installed by the CxA.

1. Coordinates and directs the commissioning activities using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
2. Coordinate the commissioning work and, with the GC, ensure that commissioning activities are being scheduled into the master schedule.
3. Revise, as necessary, the Commissioning Plan—Construction Phase.
4. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
5. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.
6. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
7. Review and comment on normal GC submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
8. Write and distribute prefunctional tests and checklists.
9. Develop an enhanced start-up and initial systems checkout plan with Subs.
10. Perform site visits, as necessary, to observe component and system installations. Attends selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
11. Witness all or part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify owner's representative of any deficiencies in results or procedures.
12. Witness all or part of any ductwork testing and cleaning procedures, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify owner's representative of any deficiencies in results or procedures.
13. Approve prefunctional tests and checklist completion by reviewing prefunctional checklist reports and by selected site observation and spot checking.
14. Approve systems startup by reviewing start-up reports and by selected site observation.
15. Review TAB execution plan.
16. Oversee sufficient functional testing of the control system and approve it to be used for TAB, before TAB (both hydronic and air) is executed.
17. Approve air and water systems balancing by spot testing, by reviewing completed reports and by selected site observation.
18. With necessary assistance and review from installing sub contractors, write the functional performance test procedures for equipment and systems. This may include energy management control system trending, stand-alone datalogger monitoring or manual functional testing. Submit to GC for review, and for approval if required.
19. Analyze any functional performance trend logs and monitoring data to verify performance.
20. Coordinate, witness and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
21. Maintain a Master Issues Log (master deficiency and resolution log) and a separate

- testing record. Observations and issues to be included on this Log include, but are not limited to, those that are variance with the Contract Documents, the OPR, the Design Intent and/or that compromise the Owner's ability to adequately service and maintain the equipment and systems. Provide the GC with written progress reports and test results with recommended actions.
22. Witness performance testing of smoke control systems by others and all other owner contracted tests or tests by manufacturer's personnel over which the CxA may not have direct control. Document these tests and include this documentation in Commissioning Record.
 23. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
 24. Oversee and approve the training plan by the GC and subcontractors for the Owner's operating personnel.
 25. Compile and maintain a commissioning record.
 26. Review the preparation of the O&M manuals. The CxA will issue comments to the A/E and the OR.
 27. Provide a final commissioning report.
 28. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.
 29. Return to the completed project site for Quarterly M & V with Owner personnel for a duration of 12 months warranty period and review with facility staff the current building operation and the condition is performing in compliance with design intent of the project design and to ensure issues related to the original and seasonal commissioning are still in tact. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.

1.13 SYSTEMS TO BE COMMISSIONED

A. The following checked systems will be commissioned in this project.

Equipment and System	Applicable Specification Sections:	Equipment and System	Applicable Specification Sections:
HVAC System			
Special Mechanical Requirements	23 08 00 and 23 01 00	Air Distribution System	23 08 00 and 23 31 00
Scroll Heat Recovery and	23 08 00	Exhaust and Ventilating Fans	23 08 00 and 23 34 00
Air to Air Heat Recovery and	23 64 28 23 08 00	Air Terminal Units	23 08 00 and 23 36 00
Modular Indoor Air Handling Units	23 72 00 23 08 00 and 23 73 00	Condensing Boilers	23 08 00 and 23 52 16
Hydronic Unit Heaters	23 08 00 and 23 83 30	Plumbing Systems	
Finned Tube Radiant Heaters	23 08 00 and 23 83 60	Special Plumbing Requirements	22 08 00 and 22 01 00
Hydronic Heating Convection Units	23 08 00 and 23 83 61 23 08 00	Natural Gas Water Heaters	22 08 00 and 22 34 00
Humidifiers and	23 85 00	Electrical Systems	
Testing and Balancing and	23 08 00 23 08 01 23 08 00 and 23 09 00	Network Lighting Controls	26 08 00 and 26 09 43
Environmental Control System	23 08 00 and 23 21 50	Variable Frequency Motor Controls	26 08 00 and 26 29 23
Hydronic Pumps		Packaged Engine Generator Assemblies	26 08 00 and 26 32 00
Refrigerant Monitoring System	23 08 00 and 23 23 50	Transfer Switches	26 08 00 and 26 36 00
Chemical Water Treatment	23 08 00 and 23 25 00	Lighting, Fixtures, Lamps and Ballasts	26 08 00 and 26 50 00

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the GC for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities. Two-way radios shall be provided by the GC.
- B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site, except for stand-alone datalogging equipment that may be used by the CxA.
- C. Datalogging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.
- E. Refer to Section 01 91 13, Part 3.6 E for details regarding equipment that may be required to simulate required test conditions.

PART 3 - EXECUTION

3.1 MEETINGS

- A. Scoping Meeting: Within 90 days of commencement of construction, the CxA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. At this meeting, the Cx process will be reviewed. In addition, the flow of documents, how much submittal data the CxA will receive and the testing (FPT) protocols will be discussed. The Cx Plan will be reviewed, along with a general list of each party's responsibilities. Prior to the meeting, the CxA is given the latest construction schedule by the GC, detailed by trade and task. The CxA will discuss the Cx milestones and coordination of the Cx tasks with the construction schedule.
- B. Meeting minutes from the Scoping Meeting will be distributed to all parties by the CxA. Information gathered from this meeting will allow the CxA to revise the Commissioning Plan to its "final" version, which will also be distributed to all parties.
- C. Miscellaneous Meetings. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with the GC and discipline Subcontractors. The CxA will plan these meetings

and will minimize unnecessary time being spent by the GC and Subcontractors. These meetings may be held monthly, until the final three (3) months of construction when they may be held as frequently as one per week.

3.2 REPORTING

- A. The CxA will provide regular reports to the GC and the OR, with increasing frequency as construction and commissioning progresses. Standard forms are provided and referenced in the Commissioning Plan.
- B. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc. On a periodic basis, in conjunction with our site observation visits, we will update and issue a Master Issues Log (master deficiency and resolution log). Observations and issues to be included on this Log include, but are not limited to, those that are variance with the Contract Documents, the OPR, the Design Intent and/or that compromise the Owner's ability to adequately service and maintain the equipment and systems.
- C. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.
- D. A final summary report (about four to six pages, not including backup documentation) by the CxA will be provided to the GC and OR, focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report. Prefunctional checklists, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record in the O&M manuals.
- E. The sample reports and forms included in the Commissioning Plan Appendices are to provide the GC and the Subcontractors with an example of a format and an indication of the rigor of the required documentation for various report types.

3.3 SUBMITTALS

- A. The CxA will provide appropriate contractors with a specific request for the type of submittal documentation the CxA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning authority. All documentation requested by the CxA will be included by the Subs in their O&M manual contributions.
 - 1. Requested Submittals:
 - a. Air Handling Units
 - b. Air Terminal Units
 - c. Air-to-Air Heat Recovery / Environmental Control System
 - d. Building Automation System
 - e. Blower Coil Unit – Cooling / Heating
 - f. Coils – Cooling and Heating
 - g. Condensing Boilers

- h. Domestic Water Heaters
 - i. Piping Insulation
 - j. Ductwork Insulation
 - k. Emergency Generator
 - l. Exhaust and Ventilating Fans
 - m. Fan Coil Units
 - n. Finned Tube Radiant Heaters
 - o. Humidifiers
 - p. Hydronic Heating Convection Units
 - q. Hydronic Pumps
 - r. Hydronic Unit Heaters
 - s. Lighting Controls
 - t. Packaged Generator Assemblies
 - u. Pipe Insulation
 - v. Refrigerant Monitoring System
 - w. Scroll Heat Recovery
 - x. Testing, Adjusting, and Balancing
 - y. Transfer Switches
 - z. Variable Frequency / Variable Speed Drives
2. Requested Shop Drawings:
- a. Building Automation System (BAS)
 - b. Building Distribution Piping
 - c. Ductwork
 - d. Lighting Control System
- B. The Commissioning authority will review and provide comments on submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The Commissioning authority will notify the GC, Owner Representative, or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.
- C. The CxA may request additional clarification from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the final approved control shop drawings. The CxA will utilize the final (approved) control shop drawings to develop the functional performance test scripts and protocols.
- D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the GC and Subcontractors, though the CxA will review and approve them.
- E. GC and Subcontractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the Commissioning Authority's review.
- 3.4 START-UP, VERIFICATION CHECKLISTS AND INITIAL CHECKOUT
- A. The following procedures apply to all equipment to be commissioned, according to Section 1.14, Systems to be Commissioned. Some systems that are not comprised so much of actual dynamic machinery, e.g., electrical system power quality, may have very simplified PCs and startup.

- B. General. Verification checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
- C. Start-up and Initial Checkout Plan. The CxA shall assist the commissioning team members responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for prefunctional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms. Contractor, subcontractors and manufacturer's technicians shall be responsible for executing functional performance tests for their representative equipment and systems.
1. The CxA develops verification checklists for all equipment and/or systems to be commissioned and delivers the checklists to the Contractor(s) for completion. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
 2. These checklists and tests are provided by the CxA to the Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form will have more than one trade responsible for its execution.
 3. The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the CxA's checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. The full start-up plan could consist of something as simple as:
 - a. The CxA's prefunctional checklists.
 - b. The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - c. The manufacturer's normally used field checkout sheets.
 4. The subcontractor submits the full startup plan to the CxA for review and approval.
 5. The CxA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
 6. The full start-up procedures and the approval form may be provided to the GC for review and approval, depending on management protocol.
- D. Sensor and Actuator Calibration.
1. All field-installed temperature, relative humidity, CO, CO₂ and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved by the Owner and/or EOR before-hand. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
 2. Final calibration tolerances shall be as specified by the Engineer-of-Record. However, absent of specific information, the enclosed shall apply.

3. All procedures used shall be fully documented on the prefunctional checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
4. Sensor Calibration Methods.
 - a. All Sensors. Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable, are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within +0.2°F of each other for temperature and within a tolerance equal to +2% of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
 - b. Sensors Without Transmitters--Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.
 - c. Sensors With Transmitters--Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
 - d. Critical Applications. For critical applications (process, manufacturing, etc.) more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.

Tolerances, Standard Applications			
Sensor	Required Tolerance (+/-)	Sensor	Required Tolerance (+/-)
Cooling coil, chilled and condenser water temps	0.4F	Flow rates, water	4% of design
AHU wet bulb or dew point	2.0F	Relative humidity	4% of design
Hot water coil and boiler water temp	1.5F	Combustion flue temps	5.0F
Outside air, space air, duct air temps	0.4F	Oxygen or CO2 monitor	0.1 % pts
Watthour, voltage & amperage	1% of design	CO monitor	0.01 % pts
		Natural gas and oil flow rate	1% of design

Pressures, air, water and gas	3% of design	Steam flow rate	3% of design
Flow rates, air	10% of design	Barometric pressure	0.1 in. of Hg

5. Valve and Damper Stroke Setup and Check.

- a. EMS Readout. For all valve and damper actuator positions checked, verify the actual position against the BAS readout.
- b. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

6. Closure for heating coil valves (NO): Set heating setpoint 20°F above room temperature. Observe valve open. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set heating setpoint to 20°F below room temperature. Observe the valve close. For pneumatics, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

7. Closure for cooling coil valves (NC): Set cooling setpoint 20°F above room temperature. Observe the valve close. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling setpoint to 20°F below room temperature. Observe valve open. For pneumatics, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

E. Execution of Verification Checklists and Startup.

1. Four weeks prior to startup, the Subs and vendors schedule startup and checkout with the GC and the CxA. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
2. The CxA shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, (in which case a sampling strategy may be used as approved by the GC). In no case will the number of units witnessed be less than four on any one building, nor less than 20% of the total number of identical or very similar units.
3. For lower-level components of equipment, (e.g., VAV boxes, sensors, controllers), the CxA shall observe a sampling of the prefunctional and start-up procedures. The sampling procedures are identified in the commissioning plan.
4. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.
5. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

F. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the Sub or GC. The CxA shall work with the Subs and vendors to correct and

retest deficiencies or uncompleted items. The CxA will involve the GC and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA recommends approval of the execution of the checklists and startup of each system to the GC using a standard form.

3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party. Refer to Part 3.6 herein for details.

3.5 PHASED COMMISSIONING

- A. The project requires TAB, startup and performance testing to be executed in phases. Phasing shall be coordinated with the Owner, the GC, CxA, and A/E and be reflected in the overall project schedule and commissioning schedule by the contractor. Final performance testing of all systems will be as required by the phasing plan. The performance testing of the “systems as a whole” will be performed before final turnover of the entire project.

3.6 FUNCTIONAL PERFORMANCE TESTING

- A. This sub-section applies to all commissioning functional testing for all divisions.
- B. The general list of equipment to be commissioned is found in Section 01 91 13, Part 1.14. The specific system functional performance tests (with required modes and sequences to be tested) will be developed after complete review of the control shop drawings and discussion with the Engineer-of-Record.
- C. The parties responsible to execute each test are the installing contractors and associated vendors, manufacturer’s representatives and technicians.
- D. Objectives and Scope. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
 1. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.
 2. Development of Test Procedures. Before test procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor responsible to execute a test, shall provide limited assistance to the CxA in developing the procedures review (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CxA shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA may submit the tests to the A/E for review, if requested.

3. The CxA shall review owner-contracted, factory testing or required owner acceptance tests which the CxA is not responsible to oversee, including documentation format, and shall determine what further testing or format changes may be required to comply with the Specifications. Redundancy of testing shall be minimized.
4. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.
5. The test procedure forms developed by the CxA shall include (but not be limited to) the following information:
 - a. System and equipment or component name(s)
 - b. Equipment location and ID number
 - c. Unique test ID number, and reference to unique prefunctional checklist and start-up documentation ID numbers for the piece of equipment
 - d. Date
 - e. Project name
 - f. Participating parties
 - g. A copy of the specification section describing the test requirements
 - h. A copy of the specific sequence of operations or other specified parameters being verified
 - i. Formulas used in any calculations
 - j. Required pre-test field measurements
 - k. Instructions for setting up the test.
 - l. Special cautions, alarm limits, etc.
 - m. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
 - n. Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
 - o. A section for comments
 - p. Signatures and date block for the CxA

E. Test Methods.

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers. The final functional performance test protocols, as developed by the CxA, shall specify which methods shall be used for each test. The CxA may substitute specified methods or require an additional method to be executed, other than what was specified, with the approval of the GC. This may require a change order and adjustment in charge to the Owner. The CxA will determine which method is most appropriate for tests that do not have a method specified.
2. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overwritten Values. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

4. Simulated Signals. Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
 5. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout setpoint to be 2F above the current outside air temperature.
 6. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during prefunctional testing.
 7. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
 8. Sampling. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. The specific recommended sampling rates for each type of equipment will be dictated by the CxA. It is noted that no sampling by Subs is allowed in prefunctional checklist execution.
 - a. A common sampling strategy referenced in the Specifications as the “xx% Sampling—yy% Failure Rule” is defined by the following example.

xx = the percent of the group of identical equipment to be included in each sample.

yy = the percent of the sample that if failing, will require another sample to be tested.
 - b. The example below describes a 20% Sampling—10% Failure Rule.
 - 1) Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the “first sample.”
 - 2) If 10% (yy) of the units in the first sample fail the functional performance tests, test another 20% of the group (the second sample).
 - 3) If 10% of the units in the second sample fail, test all remaining units in the whole group.
 - 4) If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.
- F. Coordination and Scheduling. The Subs shall provide sufficient notice to the CxA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the GC and affected Subs. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests.

1. In general, functional testing is conducted after prefunctional testing and startup has been satisfactorily completed. The control system is sufficiently tested and approved by the CxA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

- G. Test Equipment. Refer to Section 01 91 13, Part 2 for test equipment requirements.
- H. Problem Solving. The CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Subs and A/E.

3.7 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Documentation. The CxA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the GC for review and approval and to the Subs for review. The CxA will include the filled out forms in the O&M manuals.
- B. Non-Conformance.
1. The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the GC on a standard non-compliance form.
 2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
 3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the GC.
 4. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing contractor.
 - a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
 - 1) The CxA documents the deficiency and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the CxA submits the non-compliance reports to the GC for signature, if required. A copy is provided to the Sub and CxA. The Sub 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 the CxA.
 - 2) The CxA reschedules the test and the test is repeated.
 - b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - 1) The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the GC and to the Sub representative assumed to be responsible.
 - 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.
 - 3) The CxA documents the resolution process.

- 4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.
5. Cost of Retesting.
 - a. The cost for the Sub to retest a prefunctional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.
 - b. For a deficiency identified, not related to any prefunctional checklist or start-up fault, the following shall apply: The CxA will direct the retesting of the equipment once at no "charge" to the GC for their time. However, the CxA's time for a second retest will be charged to the GC, who may choose to recover costs from the responsible Sub.
 - c. The time for the CxA and GC to direct any retesting required because a specific prefunctional checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be backcharged to the GC, who may choose to recover costs from the party responsible for executing the faulty prefunctional test.
 - d. Refer to the sampling section of Section 01 91 13, Part 3.6 for requirements for testing and retesting identical equipment.
 6. The Contractor shall respond in writing to the CxA and GC at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
 7. The CxA retains the original non-conformance forms until the end of the project.
 8. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.
- C. Failure Due to Manufacturer Defect. If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the GC or OR. In such case, the Contractor shall provide the Owner with the following:
1. Within one week of notification from the GC or OR, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the GC or OR within two weeks of the original notice.
 2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
 3. The GC or OR will determine whether a replacement of all identical units or a repair is acceptable.
 4. Two examples of the proposed solution will be installed by the Contractor and the GC will be allowed to test the installations for up to one week, upon which the GC or OR will decide whether to accept the solution.
 5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
- D. Approval. The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA and by the GC, if

necessary. The CxA recommends acceptance of each test to the GC using a standard form. The GC gives final approval on each test using the same form, providing a signed copy to the CxA and the Contractor.

3.8 DEFERRED TESTING

- A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the OR. 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. The CxA shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CxA witnessing. Any final adjustments to the O&M manuals and as-builds due to the testing will be made.

3.9 TRAINING OF OWNER PERSONNEL

- A. The CxA shall coordinate with the GC to develop a training plan, including: content (curricula), qualifications of the trainers, schedule for the training, amount of time for training, etc. Refer to Section 01 79 00 Demonstration and Training for additional requirements.
- B. The CxA shall work with the GC to oversee and approve the content and adequacy of the training of Owner personnel for commissioned equipment.
 - 1. The CxA shall interview the facility manager and lead engineer to determine the special needs and areas where training will be most valuable. The Owner and CxA shall decide how rigorous the training should be for each piece of commissioned equipment. The CxA shall communicate the results to the Subs and vendors who have training responsibilities. In addition to these general requirements, the specific training requirements of the Owner's personnel, by Subs and vendors, is specified in Divisions 22, 23, and 26.
 - 2. Each Sub and vendor responsible for training will submit a written training plan to the CxA and OR for review and approval prior to training. The plan will cover the following elements:
 - a. Equipment (included in training)
 - b. Intended audience
 - c. Location of training
 - d. Objectives
 - e. Subjects covered (description, duration of discussion, special methods, etc.)
 - f. Duration of training on each subject
 - g. Instructor for each subject
 - h. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
 - i. Instructor and qualifications
 - j. For the primary HVAC equipment, the Controls Contractor shall provide a short discussion of the control of the equipment during the mechanical or electrical training conducted by others.
 - 3. The CxA works with the GC to develop the overall training plan and coordinates and schedules, with the GC, the overall training for the commissioned systems. The CxA develops criteria for determining that the training was satisfactorily completed, including attending some of the training, etc. The CxA recommends approval of the training to the

GC using a standard form. The GC also signs the approval form at one of the training sessions. Video recording of the training sessions will be provided by the Trade Contractor with media cataloged by the GC and added to the O&M manuals.

4. At the first training session, the mechanical engineer of record may be asked to present the overall system design concept and the design concept of each equipment section. This presentation shall include a review of all systems using the simplified system schematics (one-line drawings) including chilled water systems, heating water systems, supply air systems, exhaust system and outdoor air strategies.

3.10 OPERATION AND MAINTENANCE MANUALS

A. Standard O&M Manuals.

1. The specific content and format requirements for the standard O&M manuals are detailed in Division 1 Section 01 78 23.
2. The GC shall submit two draft copies of the complete operating and maintenance manual to the CxA for review. (Alternately, one electronic copy may be submitted for review.)
3. Contractor shall submit corrected final approved manuals prior to functional performance testing & training of Owners Personnel. Prior to final submittal, the CxA shall review the O&M manuals (in addition to the initial draft O&M manual), and documentation, with redline as-builts, for systems that were commissioned to verify compliance with the specifications. The CxA will communicate, through the GC, deficiencies in the manuals to the contractor or A/E, as requested. Upon a successful review of the corrections, the CxA will recommend approval and acceptance of these sections of the O&M manuals to the GC. The CxA will also review each piece of equipment warranty and verify that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.
4. CxA Review and Approval. Prior to substantial completion, the CxA shall review the O&M manuals, documentation and redline as-builts for systems that were commissioned to verify compliance with the Specifications. The CxA will communicate deficiencies in the manuals to the GC, OR or A/E, as requested. Upon a successful review of the corrections, the CxA recommends approval and acceptance of these sections of the O&M manuals to the GC, OR or A/E. The CxA also reviews each piece of equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.

B. Commissioning Record in O&M Manuals.

1. The CxA is responsible to compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed, three-ring binders and deliver it to the GC, to be included with the O&M manuals. Three copies of the manuals will be provided. The format of the manuals shall be:

Tab I-1	Commissioning Plan
Tab I-2	Final Commissioning Report (see (B.2) below)
Tab 01	System Type 1 (chiller system, packaged unit, boiler system, etc.)
Sub-Tab A	Design narrative and criteria, sequences, approvals for Equipment 1
Sub-Tab B	Startup plan and report, approvals, corrections, blank prefunctional checklists Colored Separator Sheets—for each equipment type (fans, pumps, chiller, etc.)
Sub-Tab C	Functional tests (completed), trending and analysis, approvals and corrections, training plan, record and approvals, blank functional test forms and a recommended

recommissioning schedule.

Tab 02 System Type 2.....repeat as per System 1

2. Final Report Details. The final commissioning report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas: 1) Equipment meeting the equipment specifications, 2) Equipment installation, 3) Functional performance and efficiency, 4) Equipment documentation and design intent, and 5) Operator training. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.
3. Other documentation will be retained by the CxA

3.11 WRITTEN WORK PRODUCTS

- A. The commissioning process generates a number of written work products described in various parts of the Specifications. The Commissioning Plan—Construction Phase, lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them. In summary, the written products are:

Product	Developed By
1. Develop and maintain a commissioning plan	CxA
2. Issue Cx Specifications	CxA
3. Commissioning milestones coordinated into construction schedule.	CxA with GC
4. Equipment documentation submittals	GC & Subs
5. Sequence of Operation clarifications	GC, Subs and A/E as needed
5. Develop Verification checklists	CxA
6. Startup and initial checkout plan	GC, Subs and CxA (compilation of existing documents)
7. Startup and executed Verification checklists	GC, Subs with witness of CxA & OR
8. Final TAB report	TAB
9. Develop Master Issues log (deficiencies)	CxA
10. Commissioning Progress Record	CxA
11. Deficiency reports	CxA
12. Develop Functional Performance tests	CxA with GC , BAS contractor, A / E, and OR
13. Execute the functional performance tests	GC, Subs, OR
14. Issue O&M manuals for approval / review	GC and Subs, A/E, CxA
15. Issue approved O & M manuals	GC
16. Overall training plan	GC, Subs with Factory Representatives, CxA, OR
17. Execute specific training	GC, Subs with CxA & OR as witness
18. Final commissioning report /Systems manual	CxA

END OF SECTION 01 91 13

SECTION 01 91 15 - FACILITY EXTERIOR ENCLOSURE COMMISSIONING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. This section is only a portion of the Contract Documents. All of the Contract Documents, including Conditions of the Contract and Division 01 General Requirements (including Section 01 91 13 – General Commissioning Requirements), apply to this section. Refer to Divisions 03 through 14 for requirements specific to each Section.
- B. The Owner's Project Requirements (OPR) and the A/E team's Basis of Design (BoD) are included by reference for information only.
- C. Division 01 Section 01 35 14 LEED NC 2009 Credit Summary and Section 01 81 13 Sustainable Design Requirements for Construction for additional LEED NC 2009 - v3.0 requirements related to commissioning.
- D. ASHRAE standard 90.1 -2010, ASHRAE Guideline 0-2005 (The Commissioning Process), NIBS Guideline 3-2012 Building Enclosure Commissioning Process and ASHRAE Standard 202-2013 Commissioning Process for Buildings and Systems.

1.2 SUMMARY

- A. This Section includes exterior enclosure commissioning procedures, including substructure, superstructure, exterior enclosure, and roofing construction that protects climate controlled interior space from unconditioned spaces and the exterior environment, as follows:
 - 1. Building enclosure construction, above grade including exterior opaque walls, windows, and doors including sheathing, framing, insulation and vapor barrier (as required).
 - 2. Roofing, including roofing system, roofing insulation, and skylights, hatches, and other roof openings and penetrations.
 - 3. Foundation water proofing systems and sub-drainage.
 - 4. The aforementioned items including continuity between all sections (where applicable).

- B. Commissioning
1. A systematic process ensuring that all building enclosure systems perform interactively according to the Architect's BOD and OPR. This is to be achieved through actual verification of systems performance during the construction period.
 2. The commissioning process does not take away from, or reduce the responsibility of, the General / Coordinating Contractor and installing subcontractors to provide a finished and fully functioning product.
 3. Whole building commissioning includes both MEP commissioning authorities (CxA) and building enclosure commissioning authorities. This specification only addresses building enclosure commissioning.
- C. Building Envelope/Enclosure Commissioning Service Procurement: The Owner shall retain a commissioning authority (CxA), who will hire a consultant for the Project to provide building enclosure coordination and to oversee the commissioning of building enclosure components.
- D. Systems to be Commissioned: Sections of work to be commissioned include, but are not limited to, the sections of the building that include materials and assemblies that are responsible for creating environmental separation. All performance values shall be as described within each individual section.
- E. Description: The following describes the steps involved in building enclosure commissioning and the services provided by the Building Envelope Commissioning Consultant (BECC):
1. Pre-Design/Design Phase: The steps included in this phase include the following:
 - a. Attend initial Team Meeting.
 - b. Evaluate design concepts against OPR and Architect's BOD.
 - c. Incorporate commissioning requirements into the Construction Documents via commissioning specification.
 - d. Construction Documents review prior to Bid Set.
 - e. Back check Construction Documents review.
 2. Preconstruction Phase: The steps included in this phase include the following:
 - a. Develop functional Test Plan for exterior enclosure.
 - b. Review of pertinent Shop Drawings/Submittals.
 - c. Observe construction and testing mockup(s).
 - d. Design the exterior enclosure Commissioning Plan.
 - e. Attend preconstruction conferences.
 3. Construction and Acceptance Phase: The steps included in this phase include the following:
 - a. Finalize Commissioning Plan.
 - b. Attend pertinent Progress Meetings (as needed).
 - c. Field observations of exterior enclosure installations.
 - d. Observe testing and performance of functional tests.

4. Post-Acceptance / Operations and Maintenance (O&M) Phase: The steps included in this phase include the following:
 - a. Finalization of Project commissioning record with Warranties and Closeout Documentation.
 - b. Verify applicable training procedures of building maintenance personnel.

1.3 COMMISSIONING TEAM MEMBERS

A. Commissioning Team

1. Owner (PM) and his/her Consultants.
2. General / Coordinating Contractor.
3. Designer and Design Engineers (particularly the Architect and Engineers – A/E).
4. Commissioning Authority (CxA).
5. Building Envelope/Enclosure Commissioning Consultant.
6. Specialty Subcontractors.

1.4 GENERAL / COORDINATING CONTRACTOR'S RESPONSIBILITIES

- A. Provide Coordination Drawings (see 1.7 Building Enclosure Coordination Drawings) showing the complete coordination and integration of all work of commissioned envelope systems to the Commissioning Authority.
- B. Provide cut sheets and Shop Drawings Submittals of commissioned systems to the Commissioning Authority.
- C. Attend Preconstruction, Design, and Construction Phase building enclosure coordination meetings.
- D. Provide Test Data, Letters of Compatibility, and Certificates to the Commissioning Authority.
- E. Coordinate trades in accordance with the requirements in the General Conditions and General Requirements of the Construction Contract.
- F. Permit and provide access to locations of installed systems, subsystems, and components for testing and inspection.
- G. Review test procedures to ensure feasibility, safety and equipment protection and provide necessary written limits to be used during tests.
- H. Provide schedule and accommodate field quality control tests and inspections required by the Contract Documents and product manufacturers to the Commissioning Authority.
 1. Upgrade schedule biweekly throughout the construction period.
- I. Provide spray racks and testing equipment.

- J. Provide field quality control testing and inspections on exterior enclosure construction (including filling out commissioning checklists) and submit reports to the Commissioning Authority.
- K. Participate in testing/inspection procedures meetings.
- L. Direct appropriate subcontractors to correct deficiencies as interpreted by the Commissioning Authority, Designer, and Owner.
- M. During construction, maintain as-built redline drawings for all drawings.
- N. Coordinate with manufacturers to determine specific requirements to maintain the validity of the warranty.
- O. Provide input for final commissioning documentation to the Commissioning Authority.
- P. Submit operation and maintenance data for systems, subsystems, and components to the Commissioning Authority.
- Q. Participate in maintenance orientation, training, and inspection.

1.5 DESIGNER RESPONSIBILITIES

- A. Provide paper and electronic copies of Project Drawings and Specifications to the Commissioning Authority.
- B. Provide written responses to design review comments from the Commissioning Authority or other parties as requested.
- C. Attend Design, Preconstruction, and Construction Phase coordination meetings.
- D. Participate in testing/inspection procedures meetings.
- E. Provide resolution for items for which the Commissioning Authority and Contractor may be in disagreement.

1.6 BUILDING ENCLOSURE COMMISSIONING CONSULTANT RESPONSIBILITIES

The BECC will begin work in the Pre-Design or Design Phases and continue until all building enclosure systems have been accepted by both the Designer and the Owner. The specific tasks/responsibilities of the BECC include the following:

- A. Incorporate commissioning requirements into the Construction Documents via a commissioning specification.
- B. Initial review of preliminary Construction Documents against OPR and BOD.
- C. Perform back check review of Construction Documents against OPR and BOD.

- D. Develop functional Test Plan for exterior enclosure.
- E. Review of Project Drawings and Specifications at 60%, and 95% completion for constructability, durability, and performance of exterior enclosure conformance.
- F. Review of pertinent building enclosure Shop Drawings/Submittals for compliance with Contract Documents.
- G. Provide instructions for construction of test chambers.
- H. Observe the construction of mockups and perform testing of same.
- I. Document construction of commissioned components at the completion of mockup testing. This documentation will consist of graphic representation of mockup details for use in revising shop drawings as needed.
- J. Attend pertinent Progress Meetings (as needed).
- K. Perform field observations of exterior enclosure installations.
- L. Maintain a log of deficient conditions.
- M. Conduct functional field performance (in-situ) testing.
- N. Evaluate substitution requests for compliance with Contract Documents and for compatibility with work of other subcontractors.
- O. Compile test data, inspection reports, and certificates and include them in the Systems Manual and Commissioning Process Report.
- P. Resolve conflicts in the installation of materials and assemblies specific to the building enclosure trades.
- Q. Finalize Commissioning Record with warranties and closeout documentation.
- R. Verify applicable training procedures of building maintenance personnel.

1.7 BUILDING ENCLOSURE COORDINATION DOCUMENTS

- A. The General / Coordinating Contractor shall be fully responsible for coordinating all trades, assuring proper construction sequences and schedules, and coordinating the actual installed location and interface of all work that impacts the building enclosure. Before materials are fabricated or the work begun, the General / Coordinating Contractor shall supervise and direct the creation of one complete set of Coordination Drawings showing the complete coordination and integration of all work of this Project relating to the thermal, drainage, air barrier, vapor barrier, and structural systems of enclosure. Coordination Drawings are intended to assist the General / Coordinating Contractor during construction, and may be produced using Architect's drawings, shop drawings, or other drawings as needed to communicate coordination requirements to all concerned subcontractors.

Specifically, Coordination Drawings shall include, but are not limited to the following detail conditions and system connections:

1. Low-slope roofing terminations at perimeter walls and cladding.
 2. Steep-slope roofing to low-slope roofing transitions.
 3. Steep-slope roofing terminations at perimeter walls and cladding.
 4. Metal coping and flashing terminations at wall cladding systems.
 5. Roof-to-wall conditions for at wall cladding above roof.
 6. Masonry and/or concrete panel tie-in to adjacent cladding and backup membranes.
 7. Curtain-Wall frame tie-ins to surrounding and adjacent waterproofing/air barrier membranes.
 8. Thru-wall flashing tie-ins to adjacent waterproofing/air barrier membranes.
 9. Cladding type transitions (same plane and corners).
 10. Canopy tie-in flashing at adjacent walls or cladding above.
 11. All other major transition points between trades.
- B. Mockup Shop Drawings: Provide shop drawings for construction of the window and curtain-wall mockups. Field revisions to mockups due to testing failure or other causes shall be documented in revised shop drawings to be identified as "Post Mockup Revision". The BECC will record changes to mockup details.
- C. In regard to coordination of building envelope systems and components, coordination of work and multiple trades shall include the following:
1. Building Enclosure Subcontractors: The General / Coordinating Contractor shall circulate the Coordination Drawings to other subcontractors and trades whose work might conflict with other work and require these subcontractors to accurately and neatly show the actual size and location of all their work. These subcontractors shall note any apparent conflicts, suggest alternate solutions, and return the Coordination Drawings to the General / Coordinating Contractor.
 2. After each trade completes its drawings, a meeting will be held to resolve conflicts between the trades and establish sequencing.
 - 1) Trades Coordination Drawings shall be submitted to the General / Coordinating Contractor for Designer's review prior to starting any installations.
 - 2) Coordination issues or requests for variance shall be called to the General / Coordinating Contractor's attention for the Designer's resolution.
 - 3) Contractor Review and Submission: The General / Coordinating Contractor shall carefully review, modify, and approve Coordination Drawings in cooperation with the subcontractors to assure that conflicts, if any, are resolved before work in the field is begun.

1.8 FUNCTIONAL PERFORMANCE TESTING (IN-SITU)

- A. Objectives and Scope: The objective of functional performance testing is to demonstrate that each building enclosure/assembly system is operating according to the documented design intent of the Contract Documents and in accordance with the OPR. Functional testing facilitates bringing the material assembly from a state of substantial completion to full operation. Additionally, during the testing process, areas of non-compliant performance are identified and corrected, improving the operation and functioning of the building enclosure/assemblies.

- B. Development of Test Procedures: Before test procedures are written, the Commissioning Authority shall obtain all requested documentation and a current list of change orders affecting building enclosure/assemblies. The BECC shall develop specific test procedures for each building enclosure/assembly. Prior to execution, the BECC shall provide a copy of the test procedures to the subcontractor(s) who will review the tests for feasibility, building enclosure/assemblies warranty protection.
1. The Contractor shall perform Owner-contracted performance testing.
 2. The General / Coordinating Contractor shall construct or arrange for construction of test chambers, and shall provide staging, spray racks and testing equipment and access equipment as needed to position spray racks at the exterior.
 3. The purpose of any given specific test is to verify and document compliance with the stated criteria of the Construction Documents.
- C. Test Methods
1. Functional performance testing and verification will typically follow ASTM industry standards. The BECC will determine which method is most appropriate for tests and modify test methods when an existing industry method is not available or applicable.
 2. Simulated Conditions: Simulating conditions may be allowed at the direction of the BECC, though testing actual conditions is encouraged wherever practical.
- D. Coordination and Scheduling: The General / Coordinating Contractor and their subcontractors shall provide sufficient notice to the Commissioning Authority regarding their completion schedule for the functional checklists and construction of the assemblies or building enclosure systems. The BECC will schedule functional tests through the General / Coordinating Contractor and affected subcontractors. All functional testing of all building enclosure assemblies or building enclosure systems shall be performed by the Contractor.
- E. In general, functional testing is conducted after mockup testing has been satisfactorily completed.
- F. Problem Solving: The BECC may recommend solutions to problems found, however, the burden of responsibility to solve, correct, and retest problems is with the contractor responsible for the installation of the tested assembly.
- G. Failed tests will typically result in additional testing of the failed specimen. The cost of restaging and constructing test chamber shall be responsibility of the deficient contractor. The cost for the BECC to conduct one (1) retest of the failed specimen will be borne by the Owner. Costs for subsequent retests due to failure shall be the responsibility of the deficient contractor. Test will be concluded only when satisfactory results are achieved.
- H. Non-Conformance:
1. The BECC will record the results of the functional tests in a written report. All deficiencies or non-conformance issues shall be noted and reported.
 2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the BECC. In such cases, the deficiency and resolution will be documented in the written report.
 3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.
 4. As tests progress and a deficiency is identified, the BECC discusses the issue with the executing Contractor.

- a. When there is no dispute on the deficiency and the subcontractor accepts responsibility to correct it:
 - 1) The BECC documents the deficiency and the subcontractor's response and intentions and work proceeds.
 - 2) The BECC will coordinate the rescheduled test with the affected Contractor, and the test is repeated.
- b. If there is a dispute about a deficiency regarding whether it is a deficiency or who is responsible:
 - 1) The deficiency shall be documented on the Master Issues Log (Non-Compliance Form) with the subcontractor's response and copy give to the General / Coordinating Contractor and to the subcontractor's representative assumed to be responsible.
 - 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Interpretive authority is with the A/E. Final acceptance authority is with the PM.
 - 3) The BECC documents the resolution process.
 - 4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the Statement of Correction on the Master Issues Log (Non-Compliance form), and provides it to the BECC. The BECC reschedules the test with the affected Contractors, and the test(s) are repeated until satisfactory performance is achieved.
 - 5) Any required retesting that is a result of deficient installation shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All testing equipment required to perform various enclosure tests shall be provided by the Contractor. This may include, but not be limited to: small vacuum pump assemblies and differential pressure meters for chamber testing, blower door assemblies, fans, spray racks, hoses, spray nozzles, pull-off adhesion tester, thermographic imaging camera, etc.
- B. Contractor shall provide all miscellaneous materials that may be required to accommodate testing, including, but not limited to: wood framing (for constructing air chambers), polyethylene sheathing (film), tape, sealant, caulking, etc. In addition, Contractor shall provide all required ladders, scaffolding, etc. required for access to properly perform and witness the tests.
- C. The BECC will develop the test protocols and select the in-situ areas to be tested. In addition, the BECC will direct and witness the testing. The Contractor shall execute the tests in conformance with the prescribed protocols.

PART 3 - EXECUTION

3.1 BE PERFORMANCE TESTING

- A. Site Testing: In coordination with the Contractor, the BECC will evaluate in-service performance of building enclosure assemblies and construction, and submit reports.

1. Provide site testing as scheduled at the end of this Section.
 2. Carry out testing in accordance with Section 01 91 13.
 3. Schedule and number of tests shall be conducted as defined in each BE Technical Sections (Divisions 03-09).
 4. Test requirements apply only as appropriate to the materials, components, and systems specified in each BE Technical Sections (Divisions 03-09).
- B. Adhesion Tests: Arrange for field tests to take place with joint-sealant and adhered membrane manufacturer's technical representative present. Field test sealant joints and self-adhering membranes for adhesion to substrates as follows:
1. Test each type of sealant/membrane in each installation at every substrate indicated.
 2. Perform sealant tests in compliance with ASTM C1521 Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints, Method A, ASTM C1193 X1-Method A, Guide for Use of Joint Sealants: Field-Applied Sealant Joint Hand Pull Tab, ASTM C794 Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants, and ASTM D4541 Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.
 3. For joints between dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 4. For sealants that fail adhesively, retest until satisfactory adhesion is obtained. Do not use sealants that fail to adhere to joint substrates during testing.
- C. Fenestration Field Water Tests:
1. Test installed fenestration systems according to AAMA 501.2 "Field Check of Metal Storefronts, Curtain Walls and Sloped Glazing Systems For Water Leakage," and ASTM E-1105: Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Differential
 2. Complete testing prior to installation of interior insulation and gypsum board.
 3. Contractor will work with the Test Engineer and CxA to determine necessity for additional test methods and for field chamber tests based upon evaluation of initial test results. The BECC will interpret marginal results and adjust the test procedures as appropriate.
- D. Fenestration Field Air Leakage Tests:
1. Test installed fenestration systems and interfaces with adjacent substrates according to AAMA 502-08 "Voluntary Specifications for Field Testing of Newly Installed fenestration Products", and AAMA 503-08 "Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems".
 2. Test installed fenestration systems and interfaces with adjacent substrates according to ASTM E-783: Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
 3. Complete testing prior to installation of interior insulation, gypsum wall board and interior finishes or systems that may impede the completion of the tests.
 4. Test specimen to include the perimeter material substrate and the perimeter seals.
 5. Contractor to provide powered scaffold, hose, water supply, communication and manpower to perform tests.
 6. Contractor will work with the Test Engineer and BECC to determine necessity for additional test methods and for field chamber tests based upon evaluation of initial test results. The CxA will interpret marginal results and re-write the test procedures as

appropriate.

7. Contractor to perform out-of-sequence work as required facilitating system tests.
Contractor to install all air seals / dams concealed within the mullions to facilitate air tests at curtain wall assemblies.

E. Air Barrier Field Air Leakage Tests:

1. Test installed air barrier systems and interfaces with adjacent substrates according to ASTM E1186 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems and ASTM E-783 Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
2. Complete testing prior to installation of interior insulation, gypsum wall board and interior finishes.
3. Test specimen to include the perimeter material substrate and the perimeter seals.
4. Provide powered scaffold, water, electric supply, communication and manpower to perform tests.
5. Contractor will work with the Test Engineer and CxA to determine necessity for revised test methods and for field chamber tests based upon evaluation of initial test results. The CxA will interpret marginal results and adjust the test procedures as appropriate.
6. Contractor to perform out-of-sequence work as required facilitating system tests.

F. Whole Building Air Barrier Test:

1. Test installed whole building air barrier s to ASTM E1827 Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door or ASTM E-779 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization.
2. All exterior doors must remain closed during testing. No one shall be working inside the building when testing. Opening an exterior door or window during testing will nullify the test results.
3. The testing includes pressurization testing only. Due to the large square footage of the building, depressurization testing is not required.
4. The building HVAC system will be used to help establish the building pressurizations and required cfm. The HVAC system must be operational and under control before testing begins. The air handling units (AHUs) with outdoor air should have air flow monitoring stations designed and installed as part of construction on the supply air (SA) duct of the AHU. Return Air and Relief Air should include dampers so that 100% OA can be used to pressurize the building without return to the AHU or relief to outside the building envelope.
5. The testing is for whole building testing. If CFM requirements cannot be obtained due to a substantial envelope square footage, then partial building testing may be performed and results extrapolated to the whole building.

G. Roof and Waterproofing Field Water and Air Leakage Tests:

1. Test installed roofing systems and interfaces with adjacent substrates using high- or low-voltage electronic leak detection and ASTM C1153 Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging and Capacitance.
2. Test installed roofing systems and interfaces with adjacent substrates according to ASTM E1186 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.
3. Test installed horizontal waterproofing systems and interfaces with adjacent substrates according to ASTM D5957 Guide for Floor Testing Horizontal Waterproofing Installations.
4. Complete testing prior to installation of interior insulation, gypsum wall board and

- interior ceiling finishes.
- 5. Contractor will work with the Test Engineer and CxA to determine necessity for revised or supplemental test methods. The CxA will interpret marginal results and adjust the test procedures as appropriate.

H. Concrete Moisture Tests:

- 1. Test installed concrete that will serve as a substrate to coating systems, roofing materials, and associated flashings for moisture according to ASTM D4263 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

3.2 SCHEDULE OF TESTS

- A. Window Mockup: One (1) air infiltration test and one (1) water infiltration test of the window mockup and surrounding components and systems. Infiltration tests to be performed by constructing a wood framed chamber with 10-mil clear polyethylene at the interior side and introducing negative pressure (suction) in the chamber during spray rack water test at the exterior side. Test Criteria: Air infiltration – ASTM E783-02; Water Infiltration – ASTM E1105-00. General / Coordinating Contractor shall construct or arrange construction of the test chamber per the size and specifications as provided by the BECC. General / Coordinating Contractor shall also provide or arrange staging and access equipment for positioning of spray rack.
- B. Window In-Situ Tests (Functional Performance Testing): Air and water infiltration tests of two (2) installed windows prior to interior finish installation. Test protocols to match those on window mockup. General / Coordinating Contractor shall construct or arrange construction of the test chamber per the size and specifications as provided by the BECC. General / Coordinating Contractor shall also provide or arrange staging and access equipment for positioning of spray rack.
- C. Test requirements listed below apply only as appropriate to the materials, components, and systems specified in each BE Technical Sections (Divisions 03-09). Additional test requirements may be included as specified in each BE Technical Sections (Divisions 03-09).
 - 1. Supplementary Performance Testing schedule:

Location / Test Type	Testing Standard	Description	Criteria	Schedule & Number of Tests
Field Air leakage testing:				
Aluminum Store- front	ASTM E783	Field air leakage testing	<0.09 cfm/sq. ft. at 6.24 lbf/sq. ft. (minimum).	10% completion: 1 test
Curtain Wall	ASTM E783	Field air leakage testing	<0.09 cfm/sq. ft. at 6.24 lbf/sq. ft. (minimum).	10% and 50% completion: 2 tests

Air Barrier transitions to adjacent systems, field of AB, penetrations	ASTM E783	Field air leakage tests for air barrier assembly	0.04 cfm/sq. ft. at 1.57 lbf/sq.ft.	10%, 20% and 50% completion: 3 tests

Air Barrier transitions to adjacent systems, field of AB, penetrations (4 locations, measuring 10' x 20')	ASTM E1186	Field air leakage tests for air barrier assembly	No visible sign of air leakage	Throughout construction (perform 4 smoke test and 6 bubble gun tests at each location)
Field Water leakage testing:				
Curtain Wall (min chamber size to be determined by A/E)	ASTM E1105	Field water leakage test	no water at 0.67x (specified design pressure or 20% of wind load)	2 locations @ 10% and 50%, completion (4 total tests).
Curtain Wall & AB interface (min chamber size to be determined by A/E)	ASTM E1105	Field water leakage test	no water at 0.67x (specified design pressure or 20% of wind load)	2 locations @ 10%, and 50% completion (4 total tests)
Punch window - all frame joinery and perimeter joints	AAMA 501.2	Field water testing with hose	No leaks	2 locations @ 10% completion
Windows	ASTM E1105	Field water leakage test	no water at 0.67x (specified design pressure or 20% of wind	2 locations @ 10% completion

Air Barrier with metal panel attachments in place (minimum area to be determined by A/E)	ASTM E1105	Field water leakage test	no water at zero pressure differential, 30 minute duration	2 location @ 10%, 50% completion (4 total tests).
Louver - Perimeter of louver to AB	AAMA 501.2	Field water testing with hose	No leaks	2 locations @ 10% completion
Storefront (min. chamber size to be determined by A/E)	ASTM E1105	Field water leakage test	no water at 0.67x (specified design pressure or 20% of wind load)	1 location @ 10% completion

Expansion Joints	AAMA 501.2	Field water testing with hose	No leaks	3 locations at 100% completion of all EJ including all vertical and horizontal EJs
Louver Sill pan flashing- Sill Dam Test	AAMA 511-Optional Sill Dam Test	Sill dam water testing	No water	5 locations @10% complete, prior to setting louver
Roofing membrane transitions to adjacent systems	AAMA 501.2	Field Water Testing with Hose	No leaks.	10 locations
Adhesion Testing:				
Air Barrier to transition membrane to fenestration	ASTM C1521, Method A	Sealant adhesion	Per manufacturer adhesion test data	10 locations throughout construction
Joint Sealants to substrates	ASTM C1193 X1-Method A	Sealant Adhesion - Hand Pull Tab	Per manufacturer adhesion test	10 locations throughout construction

Joint Sealants to substrates	ASTM C794	Sealant Adhesion	Per manufacturer adhesion test	10 locations throughout construction
Coatings	ASTM D4541	Pull-off Strength of Coatings using Port- able Adhesion Testers	Per manufacturer adhesion test data.	10 locations throughout construction
Electronic Leak Detection				
Roofing Systems	Electronic leak detection using high or low voltage	electronic leak detection	No breaches in roofing system	1 @ 100% completion

Thermography Imaging Survey:				
Roofing systems	ASTM C1153 / C106(modified)	Infrared imaging and capacitance	Diagnostic tool - no pass/fail criteria	N/A
Whole Building Testing:				
Whole Building Air Barrier	ASTM E1827 or ASTM E779	Whole building Air Leakage testing upon completion	0.25cfm @75 Pascal for above grade enclosure	Whole building at substantial completion of building enclosure.
Concrete Moisture Testing:				
Concrete surfaces used as substrates for coatings, roofing materials, and associated flashings	ASTM D4263	Moisture in concrete by the plastic sheet method	Per manufacturer data	Each coating system with sampling size per ASTM D4263

END OF SECTION 01 91 15

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 01 10 00 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 01 73 00 "Execution" for cutting and patching procedures.
3. Section 31 10 00 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and store.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control, and for noise control. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's and other tenants' on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches (300 mm) or more.
- F. Storage or sale of removed items or materials on-site is not permitted.
- G. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.11 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- F. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs or video, and templates.
 - 1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 - 2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 50 00 "Temporary Facilities and Controls."

- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 - 5. Maintain fire watch during and for at least 24 hours after flame-cutting operations.
 - 6. Maintain adequate ventilation when using cutting torches.
 - 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 - 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 10. Dispose of demolished items and materials promptly. Comply with requirements in Section 01 74 19 "Construction Waste Management and Disposal."
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" shall mean historic "removal" or "dismantling".
- D. Removed and Salvaged Items:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area designated by Owner.
 - 5. Protect items from damage during transport and storage.

- E. Removed and Reinstalled Items:
 - 1. Clean and repair items to functional condition adequate for intended reuse.
 - 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 - 3. Protect items from damage during transport and storage.
 - 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

- F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.
- F. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.
 - 1. Remove existing roof membrane, flashings, copings, and roof accessories.
 - 2. Remove existing roofing system down to substrate.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."

- B. Burning: Do not burn demolished materials.

3.8 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes for the following:
 - a. Footings.
 - b. Foundation walls.
 - c. Slabs-on-grade.
 - d. Suspended slabs.
 - e. Concrete toppings.
 - f. Building frame members.
 - g. Building walls.
 - h. Slab-on-metal pans

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete Subcontractor.
 - e. Special concrete finish Subcontractor.
 - 2. Review the following:

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

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement
7. Aggregates.
8. Admixtures:
 - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
9. Color pigments.
10. Fiber reinforcement.
11. Vapor retarders.
12. Floor and slab treatments.
13. Liquid floor treatments.
14. Curing materials.
 - a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
15. Joint fillers.
16. 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. Steel-fiber reinforcement content.
10. Synthetic micro-fiber content.
11. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
12. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
13. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
14. Intended placement method.
15. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. 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. Samples: For manufacturer's standard colors for color pigment.

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

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

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

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

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

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.

8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

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

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

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

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

E. Research Reports:

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

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

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

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

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

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

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

1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
 1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.
- E. Mockups: Cast concrete slab-on-ground and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
 1. Slab-On-Ground: Build panel approximately 15 feet by 15 feet (3.35 meters by 3.35 meters) in the location indicated or, if not indicated, as directed by Architect.
 - a. Divide panel into four equal panels to demonstrate saw joint cutting.
 2. Formed Surfaces: Build panel approximately 100 sq. ft. (9.3 sq. m) in the location indicated or, if not indicated, as directed by Architect.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on 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.
 - f. Permeability.

1.9 DELIVERY, STORAGE, AND HANDLING

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

1.10 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 306.1 and as follows.
 1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

2. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
 3. Do not use frozen materials or materials containing ice or snow.
 4. Do not place concrete in contact with surfaces less than 35 deg F (1.7 deg C), other than reinforcing steel.
 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M), and as follows:
1. Maintain concrete temperature at time of discharge to not exceed 95 deg F (35 deg C).
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.11 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: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301 (ACI 301M).

2.2 CONCRETE MATERIALS

- A. Source Limitations:
1. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
 2. Obtain aggregate from single source.
 3. Obtain each type of admixture from single source from single manufacturer.
- B. Cementitious Materials:
1. Portland Cement: ASTM C150/C150M. Type I or II, gray.
 2. Fly Ash: ASTM C618, Class C or F.
- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S coarse aggregate or better, graded. Provide aggregates from a single source.

1. Alkali-Silica Reaction: Comply with one of the following:
 - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
 - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
 - c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. (2.37 kg/cu. m) for moderately reactive aggregate or 3 lb./cu. yd. (1.78 kg/cu. m) for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301 (ACI 301M).
 2. Maximum Coarse-Aggregate Size: 3/4 inch (19 mm) nominal.
 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Lightweight Aggregate: ASTM C330/C330M, 1/2-inch (13-mm) nominal maximum aggregate size.
- E. Air-Entraining Admixture: ASTM C260/C260M.
- F. 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 in steel-reinforced concrete.
1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 2. Retarding Admixture: ASTM C494/C494M, Type B.
 3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
 7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.
 8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) BASF Construction Chemicals - Building Systems; Rheocrete 222+.
 - 2) Cortec Corporation; MCI- 2000.
 - 3) Grace Construction Products, W. R. Grace & Co.; DCI-S.
 - 4) Sika Corporation; FerroGard 901.
 - 5) BASF Corporation – Admixture Systems; Rheomac 300D.
 9. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).
 - a. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRC C48 at a hydraulic pressure of 200 psi (1.28 MPa) for 14 days.

- G. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments, color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
 - 1. Color: As selected by Architect from manufacturer's full range.
- H. Water and Water Used to Make Ice: ASTM C94/C94M, potable or complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4.

2.3 FIBER REINFORCEMENT

- A. Carbon-Steel-Wire Fiber: ASTM A820/A820M, Type 1, cold-drawn wire, deformed, minimum of 1.5 inches (38 mm) long, with an aspect ratio of 35 to 40.

2.4 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 10 mils (0.25 mm) thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Flatiron Films; Iron Barr 15.
 - b. Grace Construction Products, W. R. Grace & Co.; Florprufe 120.
 - c. Insulation Solutions, Inc.; Viper VaporCheck II 15.
 - d. Meadows, W. R., Inc.; Perminator 15 mil.
 - e. Raven Industries Inc.; Vapor Block 15.
 - f. Stego Industries, LLC; Stego Wrap 15 mil Class A.

2.5 FLOOR AND SLAB TREATMENTS

- A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing 3/8-inch (10-mm) sieve.

2.6 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.7 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
 - b. BASF Construction Chemicals - Building Systems; Confilm.
 - c. ChemMasters; SprayFilm.

- d. Conspec by Dayton Superior; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film (J-74).
 - f. Edoco by Dayton Superior; BurkeFilm.
 - g. Euclid Chemical Company (The), an RPM company; Eucobar.
 - h. Kaufman Products, Inc.; Vapor-Aid.
 - i. Lambert Corporation; LAMBCO Skin.
 - j. L&M Construction Chemicals, Inc.; E-CON.
 - k. Meadows, W. R., Inc.; EVAPRE.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group; MONOFILM.
 - n. Sika Corporation; SikaFilm.
 - o. SpecChem, LLC; Spec Film.
 - p. Symons by Dayton Superior; Finishing Aid.
- 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 burlap-polyethylene sheet.
- 1. Color:
 - a. Ambient Temperature Below 50 deg F (10 deg C): Black.
 - b. Ambient Temperature between 50 deg F (10 deg C) and 85 deg F (29 deg C): Any color.
 - c. Ambient Temperature Above 85 deg F (29 deg C): White.
- D. Curing Paper: Eight-foot- (2438-mm-) wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
- E. Water: Potable or complying with ASTM C1602/C1602M.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Construction Chemicals - Building Systems; Kure 1315.
 - b. ChemMasters; Polyseal WB.
 - c. Conspec by Dayton Superior; Sealcure 1315 WB.
 - d. Edoco by Dayton Superior; Cureseal 1315 WB.
 - e. Euclid Chemical Company (The), an RPM company; Super Diamond Clear VOX; LusterSeal WB 300.
 - f. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
 - g. Lambert Corporation; UV Safe Seal.
 - h. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.

2.8 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.

- C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types I and II, nonload bearing, Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Floor Slab Protective Covering: Eight-foot- (2438-mm-) wide cellulose fabric.

2.9 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3 mm) 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 (3 to 6 mm) or coarse sand, as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4100 psi (29 MPa) 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 (6 mm) 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 (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested in accordance with ASTM C109/C109M.

2.10 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301 (ACI 301M).
 - 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash or Other Pozzolans: 25 percent by mass.
 - 2. Slag Cement: 50 percent by mass.

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

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

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

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

2.11 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: ACI 318 (ACI 318M).
2. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.
3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
4. Air Content:
 - a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size.
 - b. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch (19-mm) nominal maximum aggregate size.

B. Class B: Normal-weight concrete used for foundation walls.

1. Exposure Class: ACI 318 (ACI 318M).
2. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.

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

1. Exposure Class: ACI 318 (ACI 318M).
2. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.

D. Class D: Normal-weight concrete used for interior suspended slabs.

1. Exposure Class: ACI 318 (ACI 318M).
2. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.

E. Class E: Structural lightweight concrete used for interior suspended slabs.

1. Exposure Class: ACI 318 (ACI 318M).
2. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.

- F. Class F: Normal-weight concrete used for concrete toppings.
 - 1. Exposure Class: ACI 318 (ACI 318M).
 - 2. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.

2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and ASTM C1116/C1116M, and furnish batch ticket information.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Secure facilities for storage, initial curing, and field curing of test samples, including continuous electrical power.
 - 4. Security and protection for samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

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

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

3.4 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 (150 mm), sealing vapor retarder to concrete.
 4. Lap joints 6 inches (150 mm) 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 (150 mm) 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. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 6. Space vertical joints in walls 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.
 7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

8. Use epoxy-bonding adhesive 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 (3.2 mm). 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- (3.2-mm-) 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 (13 mm) or more than 1 inch (25 mm) below finished concrete surface, where joint sealants, specified in Section 07 92 00 "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 (ACI 301M), but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- 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 (ACI 301M).
 - 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 (150 mm) 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 (ACI 301M) Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than 1-1/2 inches (38 mm) wide or 1/2 inch (13 mm) deep.
 - b. Remove projections larger than 1 inch (25 mm).
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: ACI 117 (ACI 117M) Class D.
 - e. Apply to concrete surfaces not exposed to public view.

2. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than 3/4 inch (19 mm) wide or 1/2 inch (13 mm) deep.
 - b. Remove projections larger than 1/4 inch (6 mm).
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 (ACI 117M) Class B.
 - e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish,.
 3. ACI 301 (ACI 301M) Surface Finish SF-3.0:
 - a. Patch voids larger than 3/4 inch (19 mm) wide or 1/2 inch (13 mm) deep.
 - b. Remove projections larger than 1/8 inch (3 mm).
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 (ACI 117M) Class A.
 - e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish,.
- B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:
1. Smooth-Rubbed Finish:
 - a. Perform no later than one day after form removal.
 - b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
 - c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
 2. Grout-Cleaned Rubbed Finish:
 - a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
 - b. Do not clean concrete surfaces as Work progresses.
 - c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
 - d. Wet concrete surfaces.
 - e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
 3. Cork-Floated Finish:
 - a. Mix 1 part portland cement to 1 part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.
 - b. Mix 1 part portland cement and 1 part fine sand with sufficient water to produce a mixture of stiff grout. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
 - c. Wet concrete surfaces.
 - d. Compress grout into voids by grinding surface.
 - e. In a swirling motion, finish surface with a cork float.

- C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
1. Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa).
 2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
 3. Surface Continuity:
 - a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
 - b. Maintain required patterns or variances in depths of blast to match field samples.
 4. Abrasive Blasting:
 - a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
 - b. Determine type of nozzle pressure and blasting techniques required to match field sample.
 - c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:
 - 1) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of 1/4 inch (6 mm).
- D. 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. Scratch Finish:
1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
 2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch (6 mm) in one direction.
 3. Apply scratch finish to surfaces to receive concrete floor toppings.
- C. Float Finish:
1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
 2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 (ACI A117M) tolerances for conventional concrete.

3. Apply float finish to surfaces to receive trowel finish.

D. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighthen 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 (ASTM E1155M), for a randomly trafficked floor surface:
 - a. Slabs on Ground:
 - 1) Specified overall values of flatness, F_F 25; and of levelness, F_L 20; with minimum local values of flatness, F_F 17; and of levelness, F_L 15.
 - 2) Specified overall values of flatness, F_F 35; and of levelness, F_L 25; with minimum local values of flatness, F_F 24; and of levelness, F_L 17.
 - 3) Specified overall values of flatness, F_F 45; and of levelness, F_L 35; with minimum local values of flatness, F_F 30; and of levelness, F_L 24.
 - 4) Specified Overall Value (SOV): F_F 50 and F_L 25 with minimum local value (MLV): F_F 40 and F_L 17.
 - 5) Specified Overall Value (SOV): F_F 25 and F_L 20 with minimum local value (MLV): F_F 17 and F_L 15.
 - b. Suspended Slabs:
 - 1) Specified overall values of flatness, F_F 25; and of levelness, F_L 20; with minimum local values of flatness, F_F 17; and of levelness, F_L 15.
 - 2) Specified overall values of flatness, F_F 35; and of levelness, F_L 20; with minimum local values of flatness, F_F 24; and of levelness, F_L 15.
 - 3) Specified overall values of flatness, F_F 45; and of levelness, F_L 35; with minimum local values of flatness, F_F 30; and of levelness, F_L 24.
8. Finish and measure surface, so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch (3 mm).

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

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

- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations:
 - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - 2. Construct concrete bases 6 inches (150 mm) high unless otherwise indicated on Drawings, and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
 - 3. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.
 - 4. 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.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
 - 6. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.
 - 1. Cast-in inserts and accessories, as shown on Drawings.
 - 2. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
 - 1. Comply with ACI 301 (ACI 301M) and ACI 306.1 for cold weather protection during curing.
 - 2. Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M) for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply in accordance with manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Curing Formed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:
 - 1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
 - 2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
 - 3. If forms remain during curing period, moist cure after loosening forms.
 - 4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:

- a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
 - 2) Maintain continuity of coating and repair damage during curing period.
- D. Curing Unformed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:
- 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 (300-mm).
 - 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 (300 mm), 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 (300 mm).
 - 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 (300 mm), 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 Polished Finish: 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 (300 mm).
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- d. Floors to Receive Chemical Stain:
- 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
 - 2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
 - 3) Butt sides of curing paper tight; do not overlap sides of curing paper.
 - 4) Leave curing paper in place for duration of curing period, but not less than 28 days.
- e. 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 (150 mm) 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.

f. 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.

g. 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 (ACI 117M).

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 14 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 six months.

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 (50 mm) 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 (1.18-mm) 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 (13 mm) in any dimension to solid concrete.
 - a. Limit cut depth to 3/4 inch (19 mm).
 - 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 (0.25 mm) 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 (6 mm) 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 (25 mm) 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 (19-mm) 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 (25 mm) 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. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports (Unless otherwise determined with Owner).
1. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
 2. Testing agency shall report results of tests and inspections, in writing, to 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.
- C. 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.
- D. 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.
- E. 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. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) 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. Slump Flow: ASTM C1611/C1611M:
 - 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.
4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; ASTM C173/C173M volumetric method, for structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.
6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure two sets of three 6-inch (150 mm) by 12-inch (300 mm) cylinder specimens for each composite sample.
 - b. Cast, initial cure, and field cure two sets of two standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
 - b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
 - c. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 10. 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 (3.4 MPa) if specified compressive strength is 5000 psi (34.5 MPa), or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi (34.5 MPa).
 11. 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.
 12. Additional Tests:
 - a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
 - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
 - 1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 (ACI 301M), section 1.6.6.3.
 13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 (ASTM E1155M) within 48 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 03 30 00

SECTION 03 49 00 - GLASS-FIBER-REINFORCED CONCRETE (GFRC)

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 glass-fiber-reinforced concrete (GFRC) panels consisting of GFRC, panel frames, anchors, and connection hardware.

- 1. GFRC panels include column covers.

- B. Related Requirements:

- 1. Section 05 12 00 "Structural Steel Framing" for attaching connection devices to steel framing.
 - 2. Section 07 92 00 "Joint Sealants" for elastomeric joint sealants and sealant backings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include GFRC design mixes.

- B. Shop Drawings: Show fabrication and installation details for GFRC panels including the following:

- 1. Panel elevations, sections, and dimensions.
 - 2. Thickness of facing mix, GFRC backing, and bonding pads for typical panels.
 - 3. Finishes.
 - 4. Joint and connection details.
 - 5. Erection details.
 - 6. Panel frame details for typical panels including sizes, spacings, thicknesses, and yield strengths of various members.
 - 7. Locations and details of connection hardware attached to structure.
 - 8. Sizes, locations, and details of flex, gravity, and seismic anchors for typical panels.
 - 9. Other items sprayed into panels.
 - 10. Erection sequence for special conditions.
 - 11. Relationship to adjacent materials.
 - 12. Description of loose, cast-in, and field hardware.

- C. Samples for Verification: For each type of finish indicated on exposed GFRC surfaces, representative of finish, color, and texture variations expected, approximately 12 by 12 inches (305 by 305 mm) by actual thickness.

- D. Delegated-Design Submittal: For GFRC panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Source Quality-Control Program: For GFRC manufacturer.
- B. Source Quality-Control Test Reports: For GFRC, inserts, and anchors.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," and AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handle and transport GFRC panels supported on nonstaining material and with nonstaining resilient spacers between panels.
- B. Store GFRC panels off of ground on firm, level, and smooth surfaces supported on nonstaining material and with nonstaining resilient spacers between panels. Place stored panels so identification marks are clearly visible.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CDI Casting Designs, Inc.
 - 2. Stromberg Architectural Products Inc.
 - 3. Plastrglas, Inc.
- B. Source Limitations: Obtain GFRC panels from single source from single manufacturer.
- C. Color: Match Architect's GFRC sample for color, finish, and texture.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design GFRC panels, including panel frames, anchors, and connections.
- B. Structural Performance: GFRC panels, including panel frames, anchors, and connections, shall withstand the following design loads as well as the effects of thermal- and moisture-induced dimensional changes within limits and under conditions indicated:
 - 1. Loads: As indicated on Drawings.
 - 2. Deflection Limits: Design panel frames to withstand design loads without lateral deflections greater than 1/240 of wall span.

3. Thermal Movements: Provide for thermal movements resulting from annual ambient temperature changes of 100 deg F (56 deg C).
 4. Design panel frames and connections to accommodate deflections and other building movements.
- C. PCI Manuals: Comply with requirements and recommendations in the following PCI manuals unless more stringent requirements are indicated:
1. PCI MNL 128, "Recommended Practice for Glass Fiber Reinforced Concrete Panels."
 2. PCI MNL 130, "Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products."
- D. AISI Specifications: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- E. AISC Specifications: Comply with AISC 360, "Specification for Structural Steel Buildings."

2.3 MOLD MATERIALS

- A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous GFRC surfaces within tolerances; nonreactive with GFRC and capable of producing required finish surfaces.
1. Mold-Release Agent: Commercially produced liquid-release agent that does not bond with, stain, or adversely affect GFRC surfaces and does not impair subsequent surface or joint treatments of GFRC.

2.4 GFRC MATERIALS

- A. Portland Cement: ASTM C 150/C 150M; Type I, II, or III.
1. For surfaces exposed to view in finished structure, use white of same type, brand, and source throughout GFRC production.
- B. Glass Fibers: Alkali resistant, with a minimum zirconia content of 16 percent, 1 to 2 inches (25 to 50 mm) long, specifically produced for use in GFRC, and complying with ASTM C 1666/C 1666M.
- C. Sand: Washed and dried silica, complying with composition requirements in ASTM C 144; passing a No. 20 (0.85-mm) sieve with a maximum of 2 percent passing a No. 100 (0.15-mm) sieve.
- D. Facing Aggregate: ASTM C 33/C 33M, except for gradation, and PCI MNL 130, 1/4-inch (6-mm) maximum size.
1. Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match sample.
- E. Coloring Admixture: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.

- F. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of GFRC and complying with chemical limits in PCI MNL 130.
- G. Polymer-Curing Admixture: Acrylic thermoplastic copolymer dispersion complying with PCI MNL 130.
- H. Air-Entraining Admixture: ASTM C 260/C 260M, containing not more than 0.1 percent chloride ions.

2.5 ANCHORS, CONNECTORS, AND MISCELLANEOUS MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M, finished as follows:

- 1. Finish: Zinc coated by hot-dip process according to ASTM A 123/A 123M, after fabrication, or ASTM A 153/A 153M, as applicable.

B. Carbon-Steel Bars: ASTM A 108, Grade 1018, not less than 1/4 inch (6 mm) in diameter, finished as follows:

- 1. Finish: Zinc coated by hot-dip process according to ASTM A 123/A 123M, after fabrication, or ASTM A 153/A 153M, as applicable.

C. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).

D. Bolts: ASTM A 307 or ASTM A 325 (ASTM F 568M or ASTM A 325M), finished as follows:

- 1. Finish: Zinc coated by hot-dip process according to ASTM A 123/A 123M, after fabrication, and ASTM A 153/A 153M, as applicable.

E. Reveals: Aluminum sheet ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.

- 1. Surface: Smooth, flat finish.
- 2. Exposed Coil-Coated Finishes:
 - a. Three-Coat Fluoropolymer: AAMA 620. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.
- 3. Fabricated: From material 0.050 inch (1.27 mm) thick.
- 4. Form: To created reveal indicated.
- 5. Color: As selected by Architect from manufacturer's full range.

2.6 PANEL FRAME MATERIALS

- A. Cold-Formed Steel Framing: Manufacturer's standard C-shaped steel studs, complying with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members," with minimum uncoated steel thickness of 0.053 inch (1.35 mm); with stiffened flanges, U-shaped steel track; and of the following steel sheet:

1. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, structural-steel sheet, G60 (Z180) zinc coating, of grade required by structural performance of framing.
- B. Hollow Structural Sections: Steel tubing, ASTM A 500/A 500M, Grade B, or ASTM A 513, finished as follows:
 1. Finish: Shop primed with organic zinc-rich primer complying with SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- C. Steel Channels and Angles: ASTM A 36/A 36M, finished as follows:
 1. Finish: Shop primed with organic zinc-rich primer complying with SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2.7 GFRC MIXES

- A. Mist Coat: Portland cement, sand slurry, and admixtures; of same proportions as backing mix without glass fibers.
- B. Backing Mix: Proportion backing mix of portland cement, glass fibers, sand, and admixtures to comply with design requirements. Provide nominal glass-fiber content of not less than 5 percent by weight of total mix.
- C. Polymer-Curing Admixture: 6 to 7 percent by weight of polymer-curing admixture solids to dry portland cement.
- D. Air Content: 8 to 10 percent; ASTM C 185.
- E. Coloring Admixture: Not to exceed 10 percent of cement weight.

2.8 PANEL FRAME FABRICATION

- A. Fabricate panel frames and accessories plumb, square, true to line, and with components securely fastened.
 1. Fabricate panel frames using jigs or templates.
 2. Cut cold-formed metal framing members by sawing or shearing; do not torch cut.
 3. Fasten cold-formed metal framing members by welding. Comply with AWS D1.3/D1.3M.
 4. Fasten framing members of hollow structural sections, steel channels, or steel angles by welding. Comply with AWS D1.1/D1.1M.
 5. Weld anchors to panel frames.
- B. Reinforce framing assemblies, as necessary, to withstand erection stresses.
- C. Galvanizing Repair: Touch up damaged galvanized surfaces according to ASTM A 780/A 780M.
- D. Painting Repair: Touch up damaged painted surfaces using same primer.

2.9 MOLD FABRICATION

- A. Construct molds that result in finished GFRC complying with profiles, dimensions, and tolerances indicated, without damaging GFRC during stripping. Construct molds to prevent water leakage and loss of cement paste.

- 1. Coat contact surfaces of molds with form-release agent.

2.10 GFRC FABRICATION

- A. Proportioning and Mixing: For backing mix, meter sand/cement slurry and glass fibers to spray head at rates to achieve design mix proportions and glass-fiber content according to PCI MNL 130 procedures.
- B. Spray Application: Comply with general procedures as follows:
 - 1. Spray mist coat over molds to a nominal thickness of 1/8 inch (3 mm) on planar surfaces.
 - 2. Proceed with spraying backing mix before mist coat has set, using procedures that produce a uniform thickness and even distribution of glass fibers and matrix.
 - 3. Consolidate backing mix by rolling or other technique to achieve complete encapsulation of glass fibers and compaction.
 - 4. Measure thickness with a pin gage or other acceptable method at least once for every 5 sq. ft. (0.5 sq. m) of panel surface. Take no fewer than six measurements per panel.
- C. Hand form and consolidate intricate details, incorporate formers or infill materials, and overspray before material reaches initial set to ensure complete bonding.
- D. Attach panel frame to GFRC before initial set of GFRC backing, maintaining a minimum clearance of 1/2 inch (13 mm) from GFRC backing, and without anchors protruding into GFRC backing.
- E. Build up homogeneous GFRC bonding pads over anchor feet, maintaining a minimum thickness of 1/2 inch (13 mm) over tops of anchor feet, before initial set of GFRC backing. Measure bonding pad thickness at 25 percent of anchor locations.
- F. Inserts and Embedments: Build up homogeneous GFRC bosses or bonding pads over inserts and embedments to provide enough anchorage and embedment to comply with design requirements.
- G. Curing: Employ initial curing method that ensures sufficient strength for removing units from mold. Comply with PCI MNL 130 procedures.
- H. Panel Identification: Mark each GFRC panel to correspond with identification mark on Shop Drawings. Mark each panel with its casting date.

2.11 FABRICATION TOLERANCES

- A. Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with the following dimensional tolerances. For dimensional tolerances not listed below, comply with PCI MNL 130.
 - 1. Overall Height and Width of Units, Measured at the Face Adjacent to Mold: As follows:

- a. 10 feet (3 m) or less, plus or minus 1/8 inch (3 mm).
- b. More than 10 feet (3 m), plus or minus 1/8 inch per 10 feet (3 mm per 3 m); 1/4 inch (6 mm) maximum.

2. Edge Return Thickness: Plus 1/2 inch (13 mm), minus zero inch (zero mm).
3. Architectural Facing Thickness: Plus 1/8 inch (3 mm), minus zero inch (zero mm).
4. Backing Thickness: Plus 1/4 inch (6 mm), minus zero inch (zero mm).
5. Panel Depth from Face of Skin to Back of Panel Frame or Integral Rib: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
6. Angular Variation of Plane of Side Mold: Plus or minus 1/32 inch per 3 inches (0.8 mm per 75 mm) of depth, or plus or minus 1/16 inch (1.5 mm) total, whichever is greater.
7. Variation from Square or Designated Skew (Difference in Length of Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches (3 mm per 1800 mm) or plus or minus 1/4 inch (6 mm) total, whichever is greater.
8. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).
9. Bowing: Not to exceed L/240 unless unit complies with erection tolerances using connection adjustments.
10. Length and Width of Block Outs and Openings within One Unit: Plus or minus 1/4 inch (6 mm).
11. Maximum Permissible Warpage of One Corner out of the Plane of the Other Three: 1/16 inch per 12 inches (1.5 mm per 305 mm) of distance from nearest adjacent corner.

B. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.

1. Inserts: Plus or minus 1/2 inch (13 mm).
2. Special Handling Devices: Plus or minus 3 inches (75 mm).
3. Location of Bearing Devices: Plus or minus 1/4 inch (6 mm).
4. Blockouts: Plus or minus 3/8 inch (10 mm).

2.12 FINISHES

- A. Exposed faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints, shall be uniform, straight, and sharp. Finish exposed-face surfaces of GFRC to match existing GRRC column covers.

2.13 SOURCE QUALITY CONTROL

- A. Quality-Control Testing: Establish and maintain a quality-control program for manufacturing GFRC panels according to PCI MNL 130.
 1. Test materials and inspect production techniques.
 2. Quality-control program shall monitor glass-fiber content, spray rate, unit weight, product physical properties, anchor pull-off and shear strength, and curing period and conditions.
 3. Prepare test specimens and test according to ASTM C 1228, PCI MNL 130, and PCI MNL 128 procedures.

4. Test GFRC inserts and anchors according to ASTM C 1230 to validate design values.
5. Produce test boards at a rate of no fewer than one per work shift per operator for each spray machine and for each mix design.
 - a. For each test board, determine glass-fiber content according to ASTM C 1229 and flexural yield and ultimate strength according to ASTM C 947.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine structure and conditions for compliance with requirements for installation tolerances, bearing surfaces, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ERECTION

- A. Install clips, hangers, and other accessories required for connecting GFRC panels to supporting members and backup materials.
- B. Install GFRC panels level, plumb, square, and in alignment. Provide temporary supports and bracing as required to maintain position, stability, and alignment of panels until permanent connections are completed.
 1. Maintain horizontal and vertical joint alignment and uniform joint width.
 2. Remove projecting hoisting devices.
- C. Connect GFRC panels in position by bolting or welding, or both, as indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as possible after connecting is completed.
- D. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.3/D1.3M requirements for welding, appearance, quality of welds, and methods used in correcting welding work.
 1. Protect GFRC panels from damage by field welding or cutting operations, and provide noncombustible shields as required.
- E. At bolted connections, use lock washers or other acceptable means to prevent loosening of nuts.

3.3 ERECTION TOLERANCES

- A. Erect GFRC panels to comply with the following noncumulative tolerances:
 1. Plan Location from Building Grid Datum: Plus or minus 1/2 inch (13 mm).
 2. Top Elevation from Nominal Top Elevation: As follows:
 - a. Exposed Individual Panel: Plus or minus 1/4 inch (6 mm).
 - b. Exposed Panel Relative to Adjacent Panel: 1/4 inch (6 mm).

3. Support Elevation from Nominal Elevation: As follows:
 - a. Maximum Low: 1/2 inch (13 mm).
 - b. Maximum High: 1/4 inch (6 mm).
4. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet (30 m): 1 inch (25 mm).
5. Plumb in Any 10 Feet (3 m) of Element Height: 1/4 inch (6 mm).
6. Face Width of Joint: As follows (governs over joint taper):
 - a. Panel Dimension 20 Feet (6 m) or Less: Plus or minus 1/4 inch (6 mm).
 - b. Panel Dimension More Than 20 Feet (6 m): Plus or minus 3/8 inch (9.5 mm).
7. Maximum Joint Taper: 3/8 inch (10 mm).
8. Maximum Joint Taper in 10 Feet (3 m): 1/4 inch (6 mm).
9. Differential Bowing, as Erected, between Adjacent Members of Same Design: 1/4 inch (6 mm).

3.4 REPAIRS

- A. Repairs are permitted provided structural adequacy of GFRC panel and appearance are not impaired, as approved by Architect.
- B. Mix patching materials and repair GFRC so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces.
- C. Prepare and repair accessible damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.
- D. Wire brush and clean accessible weld areas on prime-painted components and paint with same type of shop primer.
- E. Remove and replace damaged GFRC panels when repairs do not comply with requirements.

3.5 CLEANING AND PROTECTION

- A. Perform cleaning procedures, if necessary, according to GFRC manufacturer's written instructions. Clean soiled GFRC surfaces with detergent and water, using soft fiber brushes and sponges, and rinse with clean water. Prevent damage to GFRC surfaces and staining of adjacent materials.

END OF SECTION 03 49 00

SECTION 04 20 00 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Concrete building brick.
3. Decorative concrete masonry units.
4. Pre-faced concrete masonry units.
5. Concrete face brick.
6. Clay face brick.
7. Building (common) brick.
8. Hollow brick.
9. Glazed brick.
10. Structural clay facing tile.
11. Firebox brick.
12. Clay flue lining units.
13. Stone trim units.
14. Mortar and grout.
15. Steel reinforcing bars.
16. Masonry-joint reinforcement.
17. Ties and anchors.
18. Embedded flashing.
19. Miscellaneous masonry accessories.
20. Masonry-cell fill.

B. Products Installed but not Furnished under This Section:

1. Cast-stone trim in unit masonry.
2. Steel lintels in unit masonry.
3. Steel shelf angles for supporting unit masonry.
4. Cavity wall insulation.

C. Related Requirements:

1. Section 05 12 00 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
2. Section 07 21 00 "Thermal Insulation" for cavity wall insulation.
3. Section 07 62 00 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
 - 3. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.
 - 4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection:
 - 1. Decorative CMUs, in the form of small-scale units.
 - 2. Pre-faced CMUs.
 - 3. Concrete face brick, in the form of small-scale units.
 - 4. Clay face brick.
 - 5. Glazed brick.
 - 6. Glazed structural clay tile.
 - 7. Stone trim.
 - 8. Colored mortar.
 - 9. Weep holes/cavity vents.
- D. Samples for Verification: For each type and color of the following:
 - 1. Decorative CMUs.
 - 2. Pre-faced CMUs.
 - 3. Concrete face brick.
 - 4. Clay face brick, in the form of straps of five or more bricks.
 - 5. Special brick shapes.
 - 6. Glazed brick.
 - 7. Glazed structural clay tile.
 - 8. Unglazed structural clay tile.
 - 9. Stone trim.
 - 10. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 - 11. Weep holes and cavity vents.
 - 12. Accessories embedded in masonry.

1.6 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Qualification Data: For testing agency.
- C. Material Certificates: For each type and size of the following:
1. Masonry units.
 - a. Include data on material properties.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence according to ASTM C67.
 - d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing according to ASTM C67 or a list of addresses of buildings in Project's area where proposed brick has been used successfully and with a history of durability.
 - e. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 2. Integral water repellent used in CMUs.
 3. Cementitious materials. Include name of manufacturer, brand name, and type.
 4. Mortar admixtures.
 5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 6. Grout mixes. Include description of type and proportions of ingredients.
 7. Reinforcing bars.
 8. Joint reinforcement.
 9. Anchors, ties, and metal accessories.
- D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.
- F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.
- B. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 01 40 00 "Quality Requirements" for mockups.
 - 1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches (1200 mm) long by 36 inches (900 mm) high by full thickness.
 - 2. Build sample panels facing south.
 - 3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
 - 4. Clean one-half of exposed faces of panels with masonry cleaner indicated.
 - 5. Protect approved sample panels from the elements with weather-resistant membrane.
 - 6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless Architect specifically approves such deviations in writing.
- C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups for each type of exposed unit masonry construction in sizes approximately 48 inches (1200 mm) long by 36 inches (900 mm) high by full thickness, including face and backup wythes and accessories.
 - a. Include a sealant-filled joint at least 16 inches (400 mm) long in each wall mockup.
 - b. Include lower corner of window opening, framed with stone trim, at upper corner of exterior wall mockup. Make opening approximately 12 inches (300 mm) wide by 16 inches (400 mm) high.
 - c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include metal studs, sheathing, sheathing joint-and-penetration treatment, air barrier, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.
 - 2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 - 3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
 - 4. Protect accepted mockups from the elements with weather-resistant membrane.
 - 5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.

- b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.
 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe, and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.
 - 2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C1314.

2.3 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet (6 m) vertically and horizontally of a walking surface.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
 - 1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide square-edged units for outside corners unless otherwise indicated.
- B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.
1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
- C. Insulated CMUs: Where indicated, units shall contain rigid, specially shaped, molded-polystyrene insulation units complying with ASTM C578, Type I, designed for installing in cores of masonry units.
- D. CMUs: ASTM C90.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi (19.3 MPa).
 2. Density Classification: Medium weight unless otherwise indicated.
 3. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less than nominal dimensions.
 4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
 5. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.
- E. Decorative CMUs: ASTM C90.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi (14.8 MPa).
 2. Density Classification: Lightweight, unless otherwise shown.
 3. Size (Width): Manufactured to dimensions specified in "CMUs" Paragraph.
 4. Pattern and Texture:
 - a. Standard pattern, ground-face finish. Match Architect's samples.
 - b. Standard pattern, split-face finish. Match Architect's samples.
 - c. Standard pattern, split-ribbed finish. Match Architect's samples.
 - d. Scored vertically so units laid in running bond appear as square units laid in stacked bond, standard finish. Match Architect's samples.
 - e. Triple scored vertically so units laid in running bond appear as vertical units laid in stacked bond (soldier courses), standard finish. Match Architect's samples.
 5. Colors: Match Architect's samples.
 6. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample.

2.5 CONCRETE AND MASONRY LINTELS

- A. General: Provide one of the following:
- B. Concrete Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than that of CMUs.
- C. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 03 20 00 "Concrete Reinforcing," and with reinforcing bars indicated.
- D. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
 - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 - 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 - 3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 - 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Clay Face Brick: Facing brick complying with ASTM C216.
 - 1. Grade: SW.
 - 2. Type:FBX.
 - 3. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C67.
 - 4. Efflorescence: Provide brick that has been tested according to ASTM C67 and is rated "not effloresced."
 - 5. Application: Use where brick is exposed unless otherwise indicated.
 - 6. Where shown to "match existing," provide face brick matching color range, texture, and size of existing adjacent brickwork.
 - 7. Color and Texture: Match Architect's samples.

2.7 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
 - 1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C114.

- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C91/C91M.
- E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
- F. Aggregate for Mortar: ASTM C144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Aggregate for Grout: ASTM C404.
- H. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or pre-faced masonry units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.
- I. Refractory Mortar Mix: Ground fireclay or nonwater-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C199 test; or an equivalent product acceptable to authorities having jurisdiction.
- J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- K. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
- L. Water: Potable.

2.8 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60 (Grade 420).
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
- C. Masonry-Joint Reinforcement, General: ASTM A951/A951M.
 - 1. Interior Walls: Hot-dip galvanized carbon steel.

2. Exterior Walls: Stainless steel.
- D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder or truss type with single pair of side rods.
- E. Masonry-Joint Reinforcement for Multiwythe Masonry:
1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch (1.5 mm) and maximum vertical adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe. Masonry-Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized carbon steel continuous wire.

2.9 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches (38 mm) into veneer but with at least a 5/8-inch (16-mm) cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
1. Mill-Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A641/A641M, Class 1 coating.
 2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
 3. Stainless Steel Wire: ASTM A580/A580M, Type 304.
 4. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, G60 (Z180) zinc coating.
 5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
 6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
 7. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
 8. Stainless Steel Bars: ASTM A276 or ASTM A666, Type 304.
- C. Corrugated-Metal Ties: Metal strips not less than 7/8 inch (22 mm) wide with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 12.7 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from 0.030-inch- (0.76-mm-)thick steel sheet, galvanized after fabrication.
- D. Partition Top Anchors: 0.105-inch- (2.66-mm-) thick metal plate with a 3/8-inch- (9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- E. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf (445-N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.5 mm).
 2. Seismic Masonry-Veneer Anchors: Wire tie and a rib-stiffened, sheet metal anchor section with screw holes top and bottom, with projecting tabs having holes for inserting

vertical legs of wire tie formed to fit anchor section. Wire tie has sheet metal clip welded to it with integral tabs designed to engage continuous wire.

2.10 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Use the following unless otherwise indicated:

1. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, Type 304, 0.016 inch (0.40 mm) thick.
2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.

B. Flexible Flashing: Use the following unless otherwise indicated:

1. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

a. Products: Subject to compliance with requirements, provide one of the following:

- 1) Heckman Building Products Inc., No. 81 EPDM Thru – Wall Flashing.
- 2) Hohmann & Barnard, Inc; Flex-Flash.
- 3) Hyload, Inc.; Hyload Cloaked Flashing System.

b. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 0.025 inch (0.64 mm) thick, with a 0.015-inch- (0.38-mm-) thick coating of adhesive.

c. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

C. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use flexible flashing with a metal drip edge.
4. Where flashing is fully concealed, use flexible flashing.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

C. Weep/Cavity Vent Products: Use one of the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity. Use only for weeps.
 2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch (9-mm) OD by 4 inches (100 mm) long.
 3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches (9 by 38 by 89 mm) long.
 4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
 5. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe; in color selected from manufacturer's standard.
 6. Aluminum Weep Hole/Vent: Units made from sheet aluminum, designed to fit into a head joint and consisting of a vertical channel, with louvers stamped in web and with a top flap to keep mortar out of the head joint; factory primed and painted before installation to comply with Section 099113 "Exterior Painting" in color selected by Architect.
 7. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.
- D. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Configuration: Provide one of the following:
 - a. Strips, full depth of cavity and 10 inches (250 mm) high, with dovetail-shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.
 - b. Sheets or strips, full depth of cavity and installed to full height of cavity.
 - c. Sheets or strips not less than 3/4 inch (19 mm) thick and installed to full height of cavity, with additional strips 4 inches (100 mm) high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from clogging with mortar.

2.12 MASONRY-CELL FILL IF SHOWN ON DRAWINGS

- A. Loose-Fill Insulation: Perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).
- B. Lightweight-Aggregate Fill: ASTM C331/C331M.

2.13 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.14 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime unless otherwise indicated.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Verify that substrates are free of substances that impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

- G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets.

Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in bond pattern indicated on Drawings; do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches (100 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 - 1. Install compressible filler in joint between top of partition and underside of structure above.
 - 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.
 - 3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
 - 4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07 84 43 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

- A. Set stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
 - 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 - 2. Allow cleaned surfaces to dry before setting.
 - 3. Wet joint surfaces thoroughly before applying mortar.
 - 4. Rake out mortar joints for pointing with sealant.

- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
 - 1. For glazed masonry units, use a nonmetallic jointer 3/4 inch (19 mm) or more in width.
- C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 COMPOSITE MASONRY

- A. Bond wythes of composite masonry together using one of the following methods:
 - 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft. (0.42 sq. m) of wall area spaced not to exceed 16 inches (406 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (914 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.

3.7 CAVITY WALLS

- A. Bond wythes of cavity walls together using one of the following methods:
 - 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft. (0.42 sq. m) of wall area spaced not to exceed 16 inches (406 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.

3.8 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to wall framing masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten screw-attached and seismic anchors through sheathing to wall framing with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 - 2. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 - 3. Space anchors as indicated, but not more than 18 inches (458 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally, with not less than one anchor for each 2 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 8 inches (203 mm), around perimeter.
 - 4. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 25 inches (635 mm) o.c. horizontally, with not less than one anchor for each 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.
 - 5. Space anchors as indicated, but not more than 18 inches (458 mm) o.c. vertically and horizontally. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 24 inches (610 mm), around perimeter.

3.9 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
 - 1. Space reinforcement not more than 16 inches (406 mm) o.c.
 - 2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.10 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
 - 1. Provide an open space not less than 1/2 inch (13 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.11 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.
- C. Form expansion joints in brick as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches (100 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
 2. Build flanges of factory-fabricated, expansion-joint units into masonry.
 3. Build in compressible joint fillers where indicated.
 4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch (10 mm) for installation of sealant and backer rod specified in Section 07 92 00 "Joint Sealants."
- D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 07 92 00 "Joint Sealants," but not less than 3/8 inch (10 mm).
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.12 LINTELS

- A. Install steel lintels where indicated.
- B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.13 FLASHING, WEEP HOLES, AND CAVITY VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches (100 mm), and through inner wythe to within 1/2 inch (13 mm) of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches (50 mm) on interior face.
 3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches (100 mm), and 1-1/2 inches (38 mm) into the inner wythe.
 4. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 07 92 00 "Joint Sealants" for application indicated.

5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
 6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
 7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- E. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
1. Use specified weep/cavity vent products to form weep holes.
 2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes 24 inches (600 mm) o.c. unless otherwise indicated.
 4. Space weep holes formed from plastic tubing or wicking material 16 inches (400 mm) o.c.
 5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
 6. Trim wicking material flush with outside face of wall after mortar has set.
- F. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches (50 mm), to maintain drainage.
1. Fill cavities full height by placing pea gravel in cavities as masonry is laid, so that at any point, masonry does not extend more than 24 inches (600 mm) above top of pea gravel.
- G. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- H. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.
- 3.14 REINFORCED UNIT MASONRY
- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.15 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.
1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.
- E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C67 for compressive strength.
- F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.
- G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.
- H. Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for mortar air content.
- I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.
- J. Prism Test: For each type of construction provided, according to ASTM C1314 at 7 days and at 28 days.

3.16 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch (19 mm). Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot (3 mm per 300 mm). Form a wash at top of parging and a cove at bottom.
- C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.17 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 - 6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
 - 7. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 8. Clean stone trim to comply with stone supplier's written instructions.
 - 9. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.18 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
 - 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 31 20 00 "Earth Moving."
 - 3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
- C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 20 00

SECTION 04 43 13.13 - ANCHORED STONE MASONRY VENEER

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. Stone masonry anchored to concrete backup.
2. Stone masonry anchored to unit masonry backup.
3. Stone masonry anchored to cold-formed metal framing and sheathing.

B. Products Installed but Not Furnished under This Section Include:

1. Steel lintels in unit masonry.
2. Steel shelf angles for supporting unit masonry.

C. Related Requirements:

1. Section 04 20 00 "Unit Masonry" for concealed flashing.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each variety of stone, stone accessory, and manufactured product.

- B. Samples for Initial Selection: For colored mortar and other items involving color selection.

C. Samples for Verification:

1. For each stone type indicated. Include at least three Samples in each set and show the full range of color and other visual characteristics in completed Work.
2. For each color of mortar required. Label Samples to indicate types and amounts of pigments used.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, supply sources, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.
 - 1. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents contained in mockups unless Architect approves such deviations in writing.
- C. Material Test Reports:
 - 1. Stone Test Reports: For each stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous three years.
 - 2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.
- B. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Build mockups for each type of stone masonry in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high by full thickness, including face and backup wythes and accessories.
 - a. Include stone coping at top of mockup.
 - b. Include a sealant-filled joint at least 16 inches (400 mm) long in mockup.
 - c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit stone masonry above half of flashing).
 - 3. Protect accepted mockups from the elements with weather-resistant membrane.
 - 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Section 07 92 00 "Joint Sealants," Samples of materials that will contact or affect joint sealants.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.
- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

- A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.
- B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.
 - 1. Protect base of walls from rain-splashed mud and mortar splatter using coverings spread on the ground and over the wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1.10 COORDINATION

- A. Advise installers of adjacent Work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone masonry.
- B. Coordinate locations of dovetail slots installed in concrete that are to receive stone anchors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from single quarry, whether specified in this Section or in another Section of the Specifications, with resources to provide materials of consistent quality in appearance and physical properties.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.
- C. Varieties and Sources: Subject to compliance with requirements."

2.2 GRANITE

- A. Material Standard: Comply with ASTM C615/C615M.
- B. Description: Uniform, fine-grained, stone.
 - 1. Varieties and Sources: Subject to compliance with requirements, provide one of the following:
 - a. Addison Black; Addison, ME quarry.
 - b. American Black; St. Peters, PA quarry.
 - c. Chester Gray; East Otis, MA quarry.
 - d. Jet Mist 094; Rapidan, VA quarry.
 - e. Mesabi Black; Babbitt, MN quarry.
 - f. Virginia Mist; Culpepper, VA quarry.
- C. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.3 LIMESTONE

- A. Material Standard: Comply with ASTM C568/C568M.
 - 1. Classification: III High Density.
- B. Description: Dolomitic limestone.
- C. Varieties and Sources: Subject to compliance with requirements, provide one the following:
 - 1. Michels Stones
 - 2. Halquist Stone: Sandhill Rustic Lodge.

2.4 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.

1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- E. Water: Potable.

2.5 VENEER ANCHORS

- A. Materials:
 1. Stainless Steel Wire: ASTM A580/A580M, Type 304.
- B. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least a 5/8-inch (16-mm) cover on exterior face.
- C. Adjustable Masonry-Veneer Anchors:
 1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf (445-N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.5 mm).
- D. Adjustable, Seismic Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in stone masonry mortar joint, complying with the following requirements:
 1. Anchor Section: Rib-stiffened, sheet metal plate with screw holes in top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section. Size wire tie to extend at least 1-1/2 inches (38 mm) into stone masonry but with at least a 5/8-inch (16-mm) cover on exterior face.
 2. Connector Section: Sheet metal clip welded to wire tie with integral tabs designed to engage continuous wire.

2.6 STONE TRIM ANCHORS

- A. Stone Trim Anchors: Units fabricated with tabs or dowels designed to engage kerfs or holes in stone trim units and holes for fasteners or postinstalled anchor bolts for fastening to substrates or framing as indicated.
- B. Materials: Fabricate anchors from stainless steel, ASTM A240/A240M or ASTM A666, Type 304. Fasteners for Stone Trim Anchors: Annealed stainless steel bolts, nuts, and washers; ASTM F593 (ASTM F738M) for bolts and ASTM F594 (ASTM F836M) for nuts, Alloy Group 1 (A1).

2.7 EMBEDDED FLASHING MATERIALS

- A. Flexible Flashing: For flashing unexposed to the exterior, use the following unless otherwise indicated:
 - 1. Copper-Laminated Flashing: 7-oz./sq. ft. (2-kg/sq. m) copper sheet bonded with asphalt between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Weep/Vent Products: Use one of the following unless otherwise indicated:
 - 1. Wicking Material: Absorbent rope, made from UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity behind stone masonry. Use only for weeps.
 - 2. Round Plastic Tubing: Medium-density polyethylene, 3/8-inch (10-mm) OD by thickness of stone masonry.
 - 3. Rectangular Plastic Tubing: Clear butyrate, 3/8 by 1-1/2 inches (10 by 38 mm) by thickness of stone masonry.
 - 4. Mesh Weep Holes/Vents: Free-draining mesh; made from polyethylene strands, full width of head joint and 2 inches (50 mm) high by thickness of stone masonry; in color selected from manufacturer's standard.
- C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Provide one of the following configurations:
 - a. Strips, full depth of cavity and 10 inches (250 mm) wide, with dovetail-shaped notches 7 inches (175 mm) deep that prevent mesh from being clogged with mortar droppings.
 - b. Strips, not less than 3/4 inch (19 mm) thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
 - c. Sheets or strips full depth of cavity and installed to full height of cavity.
 - d. Sheets or strips not less than 3/4 inch (19 mm) thick and installed to full height of cavity with additional strips 4 inches (100 mm) high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from being clogged with mortar.

2.9 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.

2.10 FABRICATION

- A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.
 - 1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
 - 2. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
- B. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.
- C. Cut and drill sinkages and holes in stone for anchors and supports.
- D. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
 - 1. Clean sawed backs of stone to remove rust stains and iron particles.
- E. Thickness of Stone: Provide thickness indicated, but not less than the following:
 - 1. Thickness: 4 inches (100 mm) unless otherwise shown.
 - 2. Finish: Smooth.

2.11 MORTAR MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride.
 - 2. Use portland cement-lime mortar unless otherwise indicated.
 - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
 - 4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Stone Masonry: Comply with ASTM C270, Specification.
 - 1. Mortar for Setting Stone: Type N.
 - 2. Mortar for Pointing Stone: Type N.
- D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone masonry.
- B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into stone masonry are correctly installed.
- C. Examine wall framing, sheathing, and weather-resistant sheathing paper to verify that stud locations are suitable for spacing of veneer anchors and that installation will result in a weatherproof covering.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Accurately mark stud centerlines on face of weather-resistant sheathing paper before beginning stone installation.
- B. Coat concrete and unit masonry backup with asphalt dampproofing.
- C. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 INSTALLATION OF STONE MASONRY

- A. Perform necessary field cutting and trimming as stone is set.
 - 1. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.
 - 2. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
 - 3. Pitch face at field-split edges as needed to match stones that are not field split.
- B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- C. Arrange stones in range ashlar pattern with course heights as indicated, and uniform joint widths, with offset between vertical joints as indicated.
- D. Arrange stones in broken-range ashlar pattern with uniform course heights, random lengths, and uniform joint widths.
- E. Arrange stones in three-course, random-range ashlar pattern with random course heights, random lengths (interrupted coursed), and uniform joint widths.

- F. Arrange stones in pattern as shown with joint widths within tolerances indicated.
- G. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
- H. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place.
- I. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
- J. Install steel lintels where indicated. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.
- K. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Provide sealant joints of widths and at locations indicated.
 - 1. Keep sealant joints free of mortar and other rigid materials.
 - 2. Sealant joints are specified in Section 07 92 00 "Joint Sealants."
- L. Install metal expansion strips in sealant joints at locations indicated. Build flanges of expansion strips into masonry by embedding in mortar between stone masonry and backup wythe. Lap each joint 4 inches (100 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
- M. Install embedded flashing and weep holes at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
 - 1. At multiwythe masonry walls, including cavity walls, extend flashing through stone masonry, turned up a minimum of 4 inches (100 mm), and extend into or through inner wythe to comply with requirements in Section 04 20 00 "Unit Masonry."
 - 2. At lintels and shelf angles, extend flashing full length of angles but not less than 6 inches (150 mm) into masonry at each end.
 - 3. At sills, extend flashing not less than 4 inches (100 mm) at ends.
 - 4. At ends of head and sill flashing, turn up not less than 2 inches (50 mm) to form end dams.
 - 5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 07 92 00 "Joint Sealants" for application indicated.
 - 6. Extend sheet metal flashing 1/2 inch (13 mm) beyond masonry face at exterior, and turn flashing down to form a drip.
 - 7. Install metal drip edges beneath flexible flashing at exterior wall face. Stop flexible flashing 1/2 inch (13 mm) back from exterior wall face and adhere flexible flashing to top of metal drip edge.
 - 8. Install metal flashing termination beneath flexible flashing at exterior wall face. Stop flexible flashing 1/2 inch (13 mm) back from exterior wall face and adhere flexible flashing to top of metal flashing termination.
 - 9. Cut flexible flashing flush with wall face after completing masonry wall construction.
- N. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
 - 1. Use round plastic tubing to form weep holes.

2. Use wicking material to form weep holes above flashing in stone sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes 16 inches (400 mm) o.c.
 4. Space weep holes formed from plastic tubing 16 inches (400 mm) o.c.
 5. Trim wicking material used in weep holes flush with exterior wall face after mortar has set.
 6. Place pea gravel in cavities as soon as practical to a height of not less than 2 inches (50 mm) above top of flashing, to maintain drainage.
 7. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- O. Install vents in head joints at top of each continuous cavity at spacing indicated. Use round plastic tubing to form vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.
- P. Coat limestone with cementitious dampproofing as follows:
1. Stone at Grade: Beds, joints, and back surfaces to at least 12 inches (300 mm) above finish-grade elevations.
 2. Stone Extending below Grade: Beds, joints, back surfaces, and face surfaces below grade.
 3. Allow cementitious dampproofing formulations to cure before setting dampproofed stone. Do not damage or remove dampproofing in the course of handling and setting stone.

3.4 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (13 mm in 12 m) or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.
- C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet (13 mm in 6 m) or 3/4 inch in 40 feet (19 mm in 12 m) or more.
- D. Measure variation from level, plumb, and position shown in plan as a variation of the average plane of each stone face from level, plumb, or dimensioned plane.
- E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
- F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ANCHORED STONE MASONRY

- A. Anchor stone masonry to concrete with corrugated-metal veneer anchors unless otherwise indicated. Secure anchors by inserting dovetailed ends into dovetail slots in concrete.

- B. Anchor stone masonry to unit masonry with corrugated-metal veneer anchors unless otherwise indicated. Embed anchors in unit masonry mortar joints or grouted cells at a distance of at least one-half of unit masonry thickness.
- C. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement by inserting pintles into eyes of masonry joint reinforcement projecting from unit masonry.
- D. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement with vertical rods inserted through anchors and through eyes of masonry joint reinforcement projecting from unit masonry.
- E. Anchor stone masonry to unit masonry with adjustable, screw-attached veneer anchors unless otherwise indicated. Fasten anchors to unit masonry with two screws.
- F. Anchor stone masonry to stud framing with screw-attached veneer anchors unless otherwise indicated.
- G. Anchor stone masonry to wood-stud framing with corrugated-metal veneer anchors unless otherwise indicated. Fasten anchors through sheathing to studs with corrosion-resistant roofing nails.
- H. Anchor stone masonry to metal-stud framing with wire anchors unless otherwise indicated. Tie anchors to studs.
- I. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least a 5/8-inch (16-mm) cover on exterior face.
 - 1. Install continuous wire reinforcement in horizontal joints and attach to seismic veneer anchors as stone is set.
- J. Space anchors to provide not less than one anchor per 2 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (300 mm) of openings, sealant joints, and perimeter at intervals not exceeding 12 inches (300 mm).
- K. Space anchors not more than 16 inches (400 mm) o.c. vertically and 24 inches (600 mm) o.c. horizontally. Install additional anchors within 12 inches (300 mm) of openings, sealant joints, and perimeter at intervals not exceeding 12 inches (300 mm).
- L. Space anchors not more than 18 inches (450 mm) o.c. vertically and 32 inches (800 mm) o.c. horizontally, with not less than one anchor per 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (300 mm) of openings, sealant joints, and perimeter at intervals not exceeding 12 inches (300 mm).
- M. Anchor stone trim with stone trim anchors where indicated. Install anchors by fastening to substrate and inserting tabs and dowels into kerfs and holes in stone units. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.
- N. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.
- O. Rake out joints for pointing with mortar to depth of not less than 1/2 inch (13 mm) before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.6 POINTING

- A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch (10 mm) deep until a uniform depth is formed.
- B. Point stone joints by placing and compacting pointing mortar in layers of not more than 3/8 inch (10 mm) deep. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.
- C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
 - 1. Joint Profile: Concave.

3.7 ADJUSTING AND CLEANING

- A. Remove and replace stone masonry of the following description:
 - 1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
 - 2. Defective joints.
 - 3. Stone masonry not matching approved samples and mockups.
 - 4. Stone masonry not complying with other requirements indicated.
- B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
 - 5. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20, Revised II, using job-mixed detergent solution.
 - 6. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 7. Clean limestone masonry to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.8 EXCESS MATERIALS AND WASTE

- A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.

- B. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than 4 inches (100 mm) in greatest dimension.
 - 2. Mix masonry waste with at least 2 parts of specified fill material for each part of masonry waste. Fill material is specified in Section 31 20 00 "Earth Moving."
 - 3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

END OF SECTION 04 43 13.13

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Field-installed shear connectors.
3. Grout.

B. Related Requirements:

1. Section 05 31 00 "Steel Decking" for field installation of shear connectors through deck.
2. Section 05 50 00 "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.
3. Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting" and Section 09 96 00 "High-Performance Coatings" for surface-preparation and priming requirements.

1.3 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."

1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

- A. Product Data: 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.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator, and testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural steel, including chemical and physical properties.
- E. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 2. Direct-tension indicators.
 - 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 - 4. Shear stud connectors.
 - 5. Shop primers.
 - 6. Nonshrink grout.
- F. Survey of existing conditions.
- G. Source quality-control reports.
- H. Field quality-control and special inspection reports.

1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172).
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- 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."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 1. Fasteners may be repackaged provided 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 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.
 1. Select and complete connections using schematic details indicated and AISC 360.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992/A 992M.
- B. Channels, Angles, 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 B, structural tubing.
- E. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.
 1. Weight Class: As indicated.
 2. Finish: Black except where indicated to be galvanized.
- F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

- A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Plain.
- B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- C. Unheaded Anchor Rods: ASTM F 1554.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 heavy-hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436, Type 1, hardened carbon steel.
 - 5. Finish: Plain.
- D. Threaded Rods: ASTM A 36/A 36M.
 - 1. Nuts: ASTM A 563 heavy-hex carbon steel.
 - 2. Washers: ASTM F 436, Type 1, hardened carbon steel.
 - 3. Finish: Plain.

2.4 PRIMER

- A. Primer: Comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
- B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- C. Galvanizing Repair Paint: ASTM A 780/A 780M.

2.5 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 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. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
 - 4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning."
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. 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.

2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop 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: Pretensioned.
- 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. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.8 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. Surfaces to be field welded.
 3. Surfaces of high-strength bolted, slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces.
 6. Surfaces enclosed in interior construction.

- 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.

2.9 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. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

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: 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 where indicated.
 - 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 unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

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: Pretensioned.
- 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.
 - 2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

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.
 - 1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - 1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

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: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting", Section 099123 "Interior Painting.", and Section 099600 "High-Performance Coatings."

END OF SECTION 05 12 00

SECTION 05 31 00 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Roof deck.
2. Composite floor deck.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for normal-weight structural concrete fill over steel deck.
2. Section 05 12 00 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 05 50 00 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
4. Section 09 91 13 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
5. Section 09 91 23 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings:

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

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

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

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

1. Power-actuated mechanical fasteners.

- D. Evaluation Reports: For steel deck, from ICC-ES.
- E. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Canam Steel Corporation; Canam Group, Inc.
 - 2. New Millennium Building Systems, LLC.
 - 3. Nucor Corp.
- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
 - 1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - a. Color: Manufacturer's standard.
 - 2. Deck Profile: Type WR, wide rib.
 - 3. Profile Depth: 1-1/2 inches.
 - 4. Design Uncoated-Steel Thickness: As indicated.
 - 5. Span Condition: Triple span or more.
 - 6. Side Laps: Overlapped.

2.3 COMPOSITE FLOOR DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Canam Steel Corporation; Canam Group, Inc.
 - 2. New Millennium Building Systems, LLC.
 - 3. Nucor Corp.

- B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
 - 1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 50, G60 zinc coating.
 - 2. Profile Depth: 2 inches.
 - 3. Design Uncoated-Steel Thickness: 0.0358 inch.
 - 4. Span Condition: Triple span or more.

2.4 ACCESSORIES

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

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

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

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

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

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

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

- H. Galvanizing Repair Paint: ASTM A 780/A 780M.

- I. 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 according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Locate deck bundles to prevent overloading of supporting members.
- C. 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.
- D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- H. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
 - 1. Weld Diameter: 5/8 inch, nominal.
 - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.
- B. Side-Lap and Perimeter Edge Fastening: As indicated, and as follows:
 - 1. Mechanically fasten with self-drilling, No. 10 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, with end joints as follows:
 - 1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.

- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.
- E. Miscellaneous Roof-Deck Accessories: Install finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

3.4 FLOOR-DECK INSTALLATION

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - 1. Weld Diameter: 5/8 inch, nominal.
 - 2. Weld Spacing: Space and locate welds as indicated.
- B. Side-Lap and Perimeter Edge Fastening: As indicated, and as follows:
 - 1. Mechanically fasten with self-drilling, No. 10 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, with end joints as follows:
 - 1. End Joints: Butted.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.
- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Prepare test and inspection reports.

3.6 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

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

END OF SECTION 05 31 00

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing.
2. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.
3. Soffit framing.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 09 21 16.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 09 22 16 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

- C. Delegated-Design Submittal: For cold-formed steel framing.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.

- B. Welding certificates.
- C. Product Certificates: For each type of code-compliance certification for studs and tracks.
- D. Evaluation Reports: For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. 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.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads: As indicated on Drawings.
 - 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Framing Supporting and/or Backing-up Masonry or Stone Veneer: Horizontal deflection of 1/600 of the wall height.
 - b. Other Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height.
 - c. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft..
 - 3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
 - 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 3/4 inch unless noted otherwise.

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
1. Wall Studs: AISI S211.
 2. Headers: AISI S212.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: As required by structural performance.
 2. Coating: G60, A60, AZ50, or GF30.
- B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
1. Grade: As required by structural performance.
 2. Coating: G60.

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Minimum Base-Metal Thickness where studs are required to be welded: 0.0538 inch.
 3. Minimum Flange Width: 1-5/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: Matching steel studs.
 2. Flange Width: 1-1/4 inches.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. 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, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

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, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0428 inch.
 - b. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.
2. Inner Track: Of web depth indicated, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0428 inch.
 - b. Flange Width: As required.

2.4 INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Minimum Flange Width: 1-5/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 1. Minimum Base-Metal Thickness: Matching steel studs.
 2. Minimum Flange Width: 1-1/4 inches.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. 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, and as follows:
 1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
 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, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0428 inch.
 - b. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.
 2. Inner Track: Of web depth indicated, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0428 inch.

- b. Flange Width: As required.

2.5 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1-5/8 inches, minimum.

2.6 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A 1003/A 1003M, 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. Stud kickers and knee braces.
 - 8. Hole-reinforcing plates.
 - 9. Backer plates.

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. 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, based on **ICC-ES AC01** as appropriate for the substrate.
 - 1. Uses: Securing cold-formed steel framing to structure.
 - 2. Type: Torque-controlled expansion anchor, Torque-controlled adhesive anchor, or adhesive anchor.
 - 3. 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.
 - 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.
- C. 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, based on ICC-ES AC70.
- D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780/A 780M.

B. Cement Grout: Portland cement, ASTM C 150/C 150M, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C 1107/C 1107M, and with a fluid consistency and 30-minute working time.

D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.9 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 Shop 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 and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine 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. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, 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.
- 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 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- 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: 16 inches maximum or as required by design.
- 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 bypassing studs and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches 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 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 Shop 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.

3.5 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

- 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: 16 inches maximum or as required by design.
- 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.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 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 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 Shop 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 ERECTION 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 and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.7 FIELD QUALITY CONTROL

- A. Testing: 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.

3.8 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

SECTION 05 50 00 - 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 ceiling-hung toilet compartments.
2. Steel framing and supports for operable partitions.
3. Steel framing and supports for overhead doors and grilles.
4. Steel framing and supports for countertops.
5. Steel tube reinforcement for low partitions.
6. Steel framing and supports for mechanical and electrical equipment.
7. Steel framing and supports for applications where framing and supports are not specified in other Sections.
8. Elevator machine beams, hoist beams, elevator sill attachment angles, four full height steel sections for elevator track in elevator shaft, attachment of the tracks to the edges of floor slab, sheet metal cants at all horizontal surfaces in elevator shafts, and divider beams.
9. Shelf angles.
10. Metal ladders.
11. Elevator pit sump covers.
12. Metal bollards.
13. Stainless steel wainscot.
14. Pipe and Downspout guards.
15. Abrasive metal nosings, treads, and thresholds.
16. Metal downspout boots with cleanouts.
17. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 04 20 00 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
3. Section 05 12 00 "Structural Steel Framing."

4. Section 32 93 00 "Plants" for tree grates.

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 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. Nonslip aggregates and nonslip-aggregate surface finishes.
 2. Prefabricated building columns.
 3. Metal nosings and treads.
 4. Paint products.
 5. Grout.
- B. Sustainable Design Submittals:
 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
 2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
 3. Laboratory Test Reports for Credit IEQ 4.2: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Small-Scale Environmental Chambers."
- C. 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 ceiling-hung toilet compartments.
 2. Steel framing and supports for operable partitions.
 3. Steel framing and supports for overhead doors and grilles.
 4. Steel framing and supports for countertops.
 5. Steel tube reinforcement for low partitions.
 6. Steel framing and supports for mechanical and electrical equipment.
 7. Steel framing and supports for applications where framing and supports are not specified in other Sections.

8. Elevator machine beams, hoist beams, elevator sill attachment angles, four full height steel sections for elevator track in elevator shaft, attachment of the tracks to the edges of floor slab, sheet metal cants at all horizontal surfaces in elevator shafts, and divider beams.
9. Shelf angles.
10. Metal ladders.
11. Elevator pit sump covers.
12. Metal bollards.
13. Pipe and Downspout guards.
14. Abrasive metal nosings, treads, and thresholds.
15. Metal downspout boots with cleanouts.
16. Loose bearing and leveling plates for applications where they are not specified in other Sections.

- D. Samples for Verification: For each type and finish of extruded nosing and tread.
- E. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- 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/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding Qualifications: Qualify procedures and personnel according to 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 and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design ladders.
- B. Structural Performance of Aluminum Ladders: Aluminum ladders shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 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 A 36/A 36M.
- C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- E. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- G. Zinc-Coated Steel Wire Rope: ASTM A 741.
 - 1. Wire-Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- H. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm).
- I. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- J. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
- K. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
- L. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- M. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

- N. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).
- O. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).
- P. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500.
- Q. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless-steel fasteners for fastening aluminum.
 - 2. Provide stainless-steel fasteners for fastening stainless steel.
 - 3. Provide stainless-steel fasteners for fastening nickel silver.
 - 4. Provide bronze fasteners for fastening bronze.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
- C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3 (ASTM A 325M, Type 3); with hex nuts, ASTM A 563, Grade C3 (ASTM A 563M, Class 8S3); and, where indicated, flat washers.
- D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 1 (A1).
- E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Anchors 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 according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- H. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting." 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.
- B. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- C. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.5 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 (1 mm) 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.
- 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 (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.6 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 girders for wood frame construction from continuous steel shapes of sizes indicated.
 - 1. Provide bearing plates welded to beams where indicated.
 - 2. Drill or punch girders and plates for field-bolted connections where indicated.
- D. Fabricate steel pipe columns for supporting steel 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 (12.7-mm) baseplates with four 5/8-inch (16-mm) anchor bolts and 1/4-inch (6.4-mm) top plates.

2.7 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 (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) 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 (50 mm) larger than expansion or control joint.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize and prime shelf angles located in exterior walls.

2.8 METAL LADDERS

A. General:

1. Comply with ANSI A14.3, except for elevator pit ladders.
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails 18 inches (457 mm) apart unless otherwise indicated.
2. Siderails: Continuous, 3/8-by-2-1/2-inch (9.5-by-64-mm) steel flat bars, with eased edges.
3. Rungs: 3/4-inch- (19-mm-) 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. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.

2.9 ELEVATOR PIT SUMP COVERS

- A. Fabricate from 1/8-inch (3.2-mm) plate with four 1-inch- (25-mm-) diameter holes for water drainage and for lifting.
- B. Provide steel angle supports as indicated.

2.10 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.

2.11 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe.
 1. Cap bollards with 1/4-inch- (6.4-mm-) thick steel plate.

2.12 STAINLESS STEEL WAINSCOT

- A. Provide a 1/16" thick, type 304 stainless steel wainscot, adhesively applied, with "J" mold cap, for all walls in the Biodiesel Room. See finish schedule height.

2.13 PIPE AND DOWNSPOUT GUARDS

- A. Fabricate guards from 3/8-inch- (9.5-mm-) thick by 12-inch- (300-mm-) wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch (50-mm) clearance between pipe and pipe guard. Drill each end for two 3/4-inch (19-mm) anchor bolts.

2.14 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

- A. Cast-Metal Units: Cast iron, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
 - 1. Nosings: Cross-hatched units, 4 inches (100 mm) wide with 1/4-inch (6-mm) lip, for casting into concrete.
 - 2. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch (19-by-19-mm) nosing, for application over bent plate treads or existing stairs.
 - 3. Thresholds: Fluted-saddle-type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with tapered edges.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Apply bituminous paint to concealed surfaces of cast-metal units.
- D. Apply clear lacquer to concealed surfaces of extruded units.

2.15 METAL DOWNSPOUT BOOTS WITH CLEANOUTS

- A. Provide downspout boots with cleanouts made from cast iron in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
- B. Prime cast-iron downspout boots with zinc-rich primer.

2.16 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.
- C. Prime plates with zinc-rich primer.

2.17 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.

- C. Galvanize and prime loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.18 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.

2.19 FINISHES, GENERAL

- 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.

2.20 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M 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 railings 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 universal shop primer.
- 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 Items: SSPC-SP 3, "Power Tool Cleaning."
- 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.

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 INSTALLING 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. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

- A. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- B. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.4 INSTALLING PIPE GUARDS

- A. Provide pipe guards at exposed vertical pipes in parking garage where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each pipe guard. Mount pipe guards with top edge 26 inches (660 mm) above driving surface.

3.5 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 07 92 00 "Joint Sealants" to provide a watertight installation.

3.6 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.7 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

END OF SECTION 05 50 00

SECTION 05 52 13 - PIPE AND TUBE RAILINGS

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 pipe and tube railings.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Steel: 72 percent of minimum yield strength.
- C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.7 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. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

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. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
 - 1. Provide galvanized finish for exterior installations AND PAINT WITH HIGH-PERFORMANCE COATING.
- C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.3 FASTENERS

- A. General: Provide the following:
 - 1. Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 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 and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Shop Primer for Galvanized Steel: Water based galvanized metal primer complying with MPI#134.
- E. 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, but not less than that required to support structural loads.
- 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 (1 mm) 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. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.
- H. 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.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- J. Form changes in direction as follows:
 - 1. As detailed.
- K. 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.
- L. Close exposed ends of railing members with prefabricated end fittings.
- M. 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 (6 mm) or less.

- N. 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 crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- O. Provide inserts 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.
- P. For railing posts set in concrete, provide steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.

2.6 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings for exterior:
 - 1. Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.
 - 2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
 - 3. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
 - 4. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

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 (2 mm in 1 m).
 - 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 (5 mm in 3 m).
- 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. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. 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.
- C. 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 (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

- A. Use metal sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

- B. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. 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.
- C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
- D. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
- E. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.
- C. Attach railings to wall with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch (38-mm) 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.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For hollow masonry anchorage, use toggle bolts.

3.6 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.7 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 05 52 13

SECTION 06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Rooftop equipment bases and support curbs.
3. Wood blocking, cants, and nailers.
4. Wood furring and grounds.
5. Wood sleepers.
6. Utility shelving.
7. Plywood backing panels.

B. Related Requirements:

1. Section 06 16 00 "Sheathing" for sheathing, subflooring, and underlayment.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater size but less than 5 inches nominal (114 mm actual) size in least dimension.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 - 1. Preservative-treated wood.
 - 2. Fire-retardant-treated wood.
 - 3. Power-driven fasteners.
 - 4. Post-installed anchors.
 - 5. Metal framing anchors.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
 - 3. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
 - C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
 - D. Application: Treat items indicated on Drawings, and the following:
 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
 5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 1. Treatment shall not promote corrosion of metal fasteners.
 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841. For enclosed roof framing, framing in attic spaces, and where high-temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.

- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
 - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
- E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.4 DIMENSION LUMBER FRAMING

- A. Non-Load-Bearing Interior Partitions: Construction or No. 2 grade of the following species:
 - 1. Hem-fir (north); NLGA.
 - 2. Mixed southern pine or southern pine; SPIB.
 - 3. Spruce-pine-fir; NLGA.
 - 4. Hem-fir; WCLIB or WWPA.
 - 5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
 - 6. Northern species; NLGA.
 - 7. Eastern softwoods; NeLMA.
 - 8. Western woods; WCLIB or WWPA.
- B. Other Framing: Construction or No. 2 species:
 - 1. Hem-fir (north); NLGA.
 - 2. Southern pine; SPIB.
 - 3. Douglas fir-larch; WCLIB or WWPA.
 - 4. Southern pine or mixed southern pine; SPIB.
 - 5. Spruce-pine-fir; NLGA.
 - 6. Douglas fir-south; WWPA.
 - 7. Hem-fir; WCLIB or WWPA.
 - 8. Douglas fir-larch (north); NLGA.
 - 9. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

2.5 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.
 - 7. Utility shelving.

- B. Utility Shelving: Lumber with 15 percent maximum moisture content of any of the following species and grades:
 - 1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or No. 2 Common (Sterling) grade; NeLMA, NLGA, WCLIB, or WWPA.
 - 2. Mixed southern pine or southern pine No. 1 grade; SPIB.
 - 3. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common grade; NLGA, WCLIB, or WWPA.
 - 4. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.6 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Screws for Fastening to Metal Framing: ASTM C1002, length as recommended by screw manufacturer for material being fastened.
- D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.
 - 2. 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).

2.8 METAL FRAMING ANCHORS

- A. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 (Z180) coating designation.
 - 1. Use for interior locations unless otherwise indicated.
- B. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
 - 1. Use for wood-preserved-treated lumber and where indicated.
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
 - 1. Use for exterior locations and where indicated.

2.9 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

- G. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal (38-mm actual) thickness.
 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
 4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.
- H. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
1. Use inorganic boron for items that are continuously protected from liquid water.
 2. Use copper naphthenate for items not continuously protected from liquid water.
- J. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- K. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 3. ICC-ES evaluation report for fastener.
- L. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully 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. Drive nails snug but do not countersink nail heads unless otherwise indicated.
- 3.2 INSTALLATION OF WOOD BLOCKING AND NAILER
- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 INSTALLATION OF WOOD FURRING

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally and vertically at 24 inches (610 mm) o.c.
- C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) o.c.

3.4 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 53

SECTION 06 16 00 - SHEATHING

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. Wall sheathing.
2. Roof sheathing.
3. Underlayment.
4. Sheathing joint and penetration treatment.

B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for plywood backing panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

- B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.
 - 1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
 - 2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 3. Include details of interfaces with other materials that form part of air barrier.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, including list of ABAA-certified installers and supervisors employed by Installer, who work on Project and testing and inspecting agency.
- B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.
- C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preserved-treated plywood.
 - 2. Fire-retardant-treated plywood.
 - 3. Foam-plastic sheathing.
 - 4. Air-barrier and water-resistant glass-mat gypsum sheathing.
- E. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.
 - 1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.
 - 1. Build integrated mockups of exterior wall assembly , 150 sq. ft. (14 sq. m), incorporating backup wall construction, window, storefront, door frame and sill, ties and other penetrations, and flashing to demonstrate crack and joint treatment and sealing of gaps, terminations, and penetrations of air-barrier sheathing assembly.
 - a. Coordinate construction of mockups to permit inspection and testing of sheathing before external insulation and cladding are installed.
 - b. Include junction with roofing membrane, building corner condition.
 - c. If Architect determines mockups do not comply with requirements, reconstruct mockups until mockups are approved.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing: an independent agency, qualified according to ASTM E329 for testing indicated, and certified by Air Barrier Association of America, Inc.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups.
- B. Mockup Testing: Air-barrier and water-resistant glass-mat gypsum sheathing assemblies shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
 2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate according to ASTM E783.
 3. Notify Architect seven days in advance of the dates and times when mockups will be tested.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

- B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance: Air-barrier and water-resistant glass-mat gypsum sheathing assembly, and seals with adjacent construction, shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.2 WOOD PANEL PRODUCTS

- A. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- B. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat all plywood unless otherwise indicated.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
 - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
 - 4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to

ASTM D6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) shall be not less than span ratings specified.

- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all plywood unless otherwise indicated.

2.5 WALL SHEATHING (VERIFY TYPE)

- A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
 - 1. Type and Thickness: Regular, 1/2 inch (13 mm).
 - 2. Size: 48 by 96 inches (1219 by 2438 mm) for vertical installation.
- B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X, coated fiberglass mat gypsum sheathing with integral weather-resistant barrier and air barrier complying with ASTM E2178.
 - 1. Thickness: 5/8 inch (15.9 mm) thick.
 - 2. Size: 48 by 96 inches (1219 by 2438 mm) for vertical installation.
 - 3. Edges: Square.
 - 4. Flashing and Transitions Strips: As acceptable to sheathing manufacturer.
 - 5. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference when tested according to ASTM E2178.
 - 6. Vapor Permeance: Minimum 20 perms (580 ng/Pa x s x sq. m) when tested according to ASTM E96/E96M, Desiccant Method, Procedure A.
 - 7. Sheathing Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa) when tested according to ASTM E2357.
 - 8. Fire Propagation Characteristics: Complies with NFPA 285 testing as part of an approved assembly.
 - 9. UV Resistance: Can be exposed to sunlight for 90 days according to manufacturer's written instructions.
 - 10. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by sheathing manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

2.6 ROOF SHEATHING

- A. Oriented-Strand-Board Sheathing: DOC PS 2, sheathing.
 - 1. Span Rating: Not less than 32/16.
 - 2. Nominal Thickness: Not less than 3/4 inch (19 mm) unless otherwise shown.

2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For roof and wall sheathing, provide fasteners of Type 304 stainless steel.
 - 2. For roof and wall sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.
- E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
 - 1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C1002.
 - 2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C954.
- G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

2.8 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 07 92 00 "Joint Sealants."
- B. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
 - 1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.
- C. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

2.9 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with ASTM D3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.
- D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to wood framing with screws.
 - 2. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 3. Install panels with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
 - 4. Install panels with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
 - 1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
 - 2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
 - 1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
 - 2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- E. Seal sheathing joints according to sheathing manufacturer's written instructions.
 - 1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
 - 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.
- F. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing:
 - 1. Install accessory materials according to sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.
 - a. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - b. Install transition strip on roofing membrane or base flashing, so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.
 - 2. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
 - 3. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
 - 4. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip, so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.

- a. Transition Strip: Roll firmly to enhance adhesion.
5. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.
6. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
7. Seal top of through-wall flashings to sheathing with an additional 6-inch- (150-mm-) wide, transition strip.
8. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
9. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

3.3 FIELD QUALITY CONTROL

- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.
- B. Testing and Inspecting Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 3. Termination mastic has been applied on cut edges.
 4. Strips and transition strips have been firmly adhered to substrate.
 5. Compatible materials have been used.
 6. Transitions at changes in direction and structural support at gaps have been provided.
 7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 8. All penetrations have been sealed.
- D. Tests: As determined by testing agency from among the following tests:
 1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
 2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783.
- E. Air barriers will be considered defective if they do not pass tests and inspections.
- F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- G. Prepare test and inspection reports.

END OF SECTION 06 16 00

SECTION 06 20 23 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior trim, including non-fire-rated interior door and sidelight frames.
2. Interior plywood, and board paneling.
3. Shelving and clothes rods.
4. Window Sills.
5. Solid Surface Material.
6. Display Walls.
7. Shop Finishing.

B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.
2. Section 09 91 23 "Interior Painting" for priming and backpriming of interior finish carpentry.

1.3 DEFINITIONS

- A. MDF: Medium-density fiberboard.
- B. MDO: Plywood with a medium-density overlay on the face.
- C. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
 1. Include data for wood-preservative treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained. Include chemical-treatment manufacturer's written instructions for finishing treated material.
 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.

- B. Samples: For each exposed product and for each color and texture specified.
- C. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.
- D. Samples for Verification:
 - 1. For each species and cut of lumber and panel products with nonfactory-applied finish, with half of exposed surface finished; 50 sq. in. (300 sq. cm) for lumber and 8 by 10 inches (200 by 250 mm) for panels.
 - 2. For foam-plastic moldings, with half of exposed surface finished; 50 sq. in. (300 sq. cm).
 - 3. For each finish system and color of lumber and panel products with factory-applied finish, 50 sq. in. (300 sq. cm) for lumber and 8 by 10 inches (200 by 250 mm) for panels.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation.
 - 1. Protect materials from weather by covering with waterproof sheeting, securely anchored.
 - 2. Provide for air circulation around stacks and under coverings.
- B. Deliver interior finish carpentry materials only when environmental conditions comply with requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet-work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.

2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by grading agency.
- B. Softwood Plywood: DOC PS 1.
- C. Hardboard: ANSI A135.4.
- D. MDF: ANSI A208.2, Grade 130.
- E. Particleboard: ANSI A208.1, Grade M-2.
- F. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper and complying with NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.
1. Color: As selected by Architect from manufacturer's full range.
- G. Solid Surface Material: 1/2 inch thick - SS-1
1. 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Silestone; Blanco Norte Leather.
 - b. Cambria; Kirkstead.
 - c. Zodiaq; Papyrus.
 2. Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC1.
1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 18 percent, respectively.
 2. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 3. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
 4. Do not use material that is warped or does not comply with requirements for untreated material.
 5. Mark lumber with treatment-quality mark of an inspection agency approved by the ALSC's Board of Review.
 - a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
 6. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
 - a. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.

2.3 INTERIOR TRIM

- A. Softwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
1. Species and Grade: Eastern white pine; NeLMA or NLGA C Select.
 2. Species and Grade: Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NLGA or WWPA C Select (Choice).
 3. Species and Grade: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; NeLMA, NLGA, or WWPA C Select (Choice).
 4. Species and Grade: White woods; WWPA C Select.
 5. Species and Grade: Douglas fir-larch or Douglas fir south; NLGA, WCLIB, or WWPA Superior or C & Btr finish.
 6. Species and Grade: Southern pine; SPIB B & B finish.
 7. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
 8. Finger Jointing: Not allowed.
 9. Face Surface: Surfaced (smooth).
- B. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
1. Species and Grade: White maple; NHLA Clear.
 2. Maximum Moisture Content: 9 percent.
 3. Finger Jointing: Not allowed.
 4. Gluing for Width: Not allowed.
 5. Veneered Material: Not allowed.
 6. Face Surface: Surfaced (smooth).
 7. Matching: Selected for compatible grain and color.
- C. Lumber Trim for Opaque Finish (Painted Finish):
1. Species and Grade: Eastern white pine; NeLMA or NLGA D Select.
 2. Species and Grade: Douglas fir-larch or Douglas fir south; NLGA, WCLIB, or WWPA Superior or C & Btr finish.
 3. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
 4. Maximum Moisture Content: 9 percent.
 5. Finger Jointing: Not allowed.
 6. Face Surface: Surfaced (smooth).
 7. Optional Material: Primed MDF of same actual dimensions as lumber indicated may be used in lieu of lumber.
- D. Softwood Moldings for Transparent Finish (Stain or Clear Finish): MMPA WM 4, N-grade wood moldings. Made to patterns included in MMPA's "WM/Series Softwood Moulding Patterns."
1. Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pines.
 2. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
 3. Finger Jointing: Not allowed.
 4. Matching: Selected for compatible grain and color.
- E. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): MMPA WM 4, N-grade wood moldings made to patterns included in MMPA's "HWM/Series Hardwood Moulding Patterns."
1. Species: White maple.
 2. Maximum Moisture Content: 9 percent.

3. Finger Jointing: Not allowed.
4. Matching: Selected for compatible grain and color.
5. Optional Material: Kiln-dried softwood or MDF, with exposed surfaces veneered with species indicated, may be used in lieu of solid wood.

2.4 PANELING

- A. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1.
1. Face Veneer Species and Cut: Rotary-cut white birch.
 2. Veneer Matching: Selected for similar color and grain.
 3. Backing Veneer Species: Same species as face veneer.
 4. Construction: Veneer core.
 5. Thickness: 7/16 inch (11 mm).
 6. Glue Bond: Type II (interior).
 7. Finish: As selected by Architect from manufacturer's full range.

2.5 SHELVING AND CLOTHES RODS

- A. Exposed Shelving: Made from the following material, 3/4 inch (19 mm) thick:
1. Particleboard with solid-wood front edge.
 2. MDF with solid-wood front edge.
- B. Shelf Cleats: 3/4-by-3-1/2-inch (19-by-89-mm) boards.
- C. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.
- D. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.
- E. Standards for Adjustable Shelf Brackets: BHMA A156.9, B04102; powder-coat-finished steel.
- F. Adjustable Shelf Brackets: BHMA A156.9, B04112; powder-coat-finished steel.
- G. Standards for Adjustable Shelf Supports: BHMA A156.9, B04071; powder-coat-finished steel.
- H. Adjustable Shelf Supports: BHMA A156.9, B04081 or B04091; powder-coat-finished steel.
- I. Clothes Rods: 1-5/16-inch- (33-mm-) diameter, aluminum tubes.
- J. Rod Flanges: Aluminum.

2.6 MISCELLANEOUS MATERIALS

- A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
- B. Low-Emitting Materials: Adhesives shall comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- C. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
- D. Paneling Adhesive: Comply with paneling manufacturer's written instructions for adhesives.
- E. Multipurpose Construction Adhesive: Formulation, complying with ASTM D3498, that is recommended for indicated use by adhesive manufacturer.

2.7 DISPLAY WALL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Marlite; Slatwall EQ 1000 Series or comparable product by one of the following:
 - 1. Spacewall International, Inc.
 - 2. US Slatwall.
- B. Display Wall Panel:
 - 1. Edges: Square Cut.
 - 2. Finish: Cheery veneer stained to match WD-2.
 - 3. Groove Size: 3 inches on center.
 - 4. Groove Inserts: Finish: Aluminum.

2.8 FABRICATION

- A. Back out or kerf backs of the following members, except those with ends exposed in finished work:
 - 1. Interior standing and running trim, except shoe and crown molds.
 - 2. Wood-board paneling.
- B. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

2.09 SHOP FINISHING

- A. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
 - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.
- C. Transparent Finish:
 - 1. Grade: Same as item to be finished.

2. Finish: System - 11, catalyzed polyurethane.
3. Staining: Match Architect's sample.
4. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
5. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

2.10 PANELING WD-1

- A. Framed Hardwood Veneer Panels: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Marlite; Surface Systems, with 1/16" Hidden Reveal or a comparable product by one of the following:
 - a. Panel Specialists Inc.; System 310.
 - b. Wall Panel Systems, Inc.; Recessed Reveal System.
2. Face Veneer Species and Cut: As selected by Architect.
3. Balancing Backer: Manufacturer's standard.
4. Veneer Matching: Book.
5. Construction: Medium-Density Fiberboard ANSI A208.2, Grade MDF. Ureaformaldehyde free.
6. Thickness: 3/4 inch (19 mm).
7. Panel Size: As indicated on the Drawings.
8. Glue Bond: Type II (interior).
9. Hardware: Manufacturer's standard mounting rail and spline hardware. Provide shims in accordance with manufacturer's instructions.
10. Panel Trim: Manufacturer's standard aluminum trim to provide 1/16 inch reveal. Color: Black.

2.12 BOARD PLANK PANELING

- A. Grade: Premium.
- B. Size: See Drawings.
- C. Wood Species and Cut: Select cherry, plain sliced.
- D. Matching Method: No matching is required between planks. Select and arrange planks for similarity of grain pattern and color between adjacent planks.
- E. Stain: Match WD-2 (Light cherry) as approved by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL

- A. Do not use materials that are unsound; warped; improperly treated or finished; inadequately seasoned; too small to fabricate with proper jointing arrangements; or with defective surfaces, sizes, or patterns.
- B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials.
 - 1. Use concealed shims where necessary for alignment.
 - 2. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 3. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
 - 4. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining interior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
 - 5. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 STANDING AND RUNNING TRIM INSTALLATION

- A. Install trim with minimum number of joints as is practical, using full-length pieces from maximum lengths of lumber available.
 - 1. Do not use pieces less than 24 inches (610 mm) long, except where necessary.
 - 2. Stagger joints in adjacent and related standing and running trim.
Miter at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint.
 - 3. Use scarf joints for end-to-end joints.

4. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
5. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
6. Install trim after gypsum-board joint finishing operations are completed.
7. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting.
8. Fasten to prevent movement or warping.
9. Countersink fastener heads on exposed carpentry work and fill holes.

3.5 PANELING INSTALLATION

- A. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels.
1. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings.
 2. Install with uniform tight joints between panels.
 3. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners.
 4. Space fasteners and adhesive as recommended by panel manufacturer.
 5. Conceal fasteners to greatest practical extent.
 6. Arrange panels with grooves and joints over supports.
 - a. Fasten to supports with nails of type and at spacing recommended by panel manufacturer.
 - b. Use fasteners with prefinished heads matching groove color.
- B. Hardboard Paneling: Install according to manufacturer's written instructions.
1. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings.
 2. Butt adjacent panels with moderate contact.
 3. Use fasteners with prefinished heads matching paneling color.
 4. Wood Stud or Furring Substrate: Install with 1-inch (25-mm) annular-ring shank hardboard nails.
 5. Plaster or Gypsum-Board Substrate: Install with 1-5/8-inch (41-mm) annular-ring shank hardboard nails.
 6. Nailing: Space nails 4 inches (100 mm) o.c. at panel perimeter and 8 inches (200 mm) o.c. at intermediate supports unless otherwise required by manufacturer.
- C. Board Paneling: Install according to manufacturer's written instructions.
1. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.
 2. Install in full lengths without end joints.
 3. Stagger end joints in random pattern to uniformly distribute joints on each wall.
 4. Install with uniform end joints with only end-matched (tongue-and-groove) joints within each field of paneling.
 5. Install with uniform end joints. Locate end joints only over furring or blocking.
 6. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards.
 7. Install with uniform tight joints between boards.
 8. Fasten paneling by face nailing, setting nails, and filling over nail heads.
 9. Fasten paneling with trim screws, set below face and filled.
 10. Fasten paneling by blind nailing through tongues.

11. Fasten paneling with paneling system manufacturer's concealed clips.
12. Fasten paneling to gypsum wallboard with panel adhesive.

3.6 SHELVING AND CLOTHES ROD INSTALLATION

- A. Cut shelf cleats at ends of shelves about 1/2 inch (13 mm) less than width of shelves and sand exposed ends smooth.
 1. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled.
 2. Space fasteners not more than 16 inches (400 mm) o.c. Use two fasteners at each framing member or fastener location for cleats 4 inches nominal (89 mm actual) in width and wider.
 3. Apply a bead of multipurpose construction adhesive to back of shelf cleats before installing.
 4. Remove adhesive that is squeezed out after fastening shelf cleats in place.
- B. Install shelf brackets according to manufacturer's written instructions, spaced not more than 32 inches (800 mm) o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
- C. Install standards for adjustable shelf supports according to manufacturer's written instructions. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Space fasteners not more than 12 inches (300 mm) o.c.
- D. Install standards for adjustable shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches (900 mm) o.c. and within 6 inches (150 mm) of ends of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
- E. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled.
 1. Install shelves, fully seated on cleats, brackets, and supports.
 2. Fasten shelves to cleats with finish nails or trim screws, set flush.
 3. Fasten shelves to brackets to comply with bracket manufacturer's written instructions.
- F. Install rod flanges for rods as indicated.
 1. Fasten to shelf cleats, framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
 2. Install rods in rod flanges.

3.7 ADJUSTING

- A. Replace interior finish carpentry that is damaged or does not comply with requirements.
 1. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.
- B. Adjust joinery for uniform appearance.

3.8 CLEANING

- A. Clean interior finish carpentry on exposed and semiexposed surfaces.
- B. Restore damaged or soiled areas and touch up factory-applied finishes if any.

3.9 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 06 20 23

SECTION 06 41 13 - WOOD-VENEER-FACED ARCHITECTURAL CABINETS

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. Wood-veneer-faced architectural cabinets.
2. Wood furring, blocking, shims, and hanging strips for installing architectural cabinets that are not concealed within other construction.
3. Shop finishing of architectural cabinets.

B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

1.3 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings: For architectural cabinets.

1. Include plans, elevations, sections, and attachment details.
2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.

4. Show locations and sizes of cutouts and holes for items installed in architectural cabinets.
 5. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
 6. Apply AWI.
- C. Samples: For each exposed product and for each color and finish specified, in manufacturer's standard size.
- D. Samples for Initial Selection: For each type of exposed finish.
- E. Samples for Verification: For the following:
1. Lumber for Transparent Finish: Not less than 5 inches (125 mm) wide by 12 inches (300 mm) long, for each species and cut, finished on one side and one edge.
 2. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished cabinets.
 3. Lumber and Panel Products with Shop-Applied Opaque Finish: 5 inches (125 mm) wide by 12 inches (300 mm) long for lumber and 8 by 10 inches (200 by 250 mm) for panels, for each finish system and color.
 4. Thermoset Decorative Panels: 8 by 10 inches (200 by 250 mm), for each color, pattern, and surface finish.
 5. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates:
1. Thermoset decorative panels.
 2. Glass.
 3. Adhesives.
- B. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
- C. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 CABINETS, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of architectural cabinets indicated for construction, finishes, installation, and other requirements.
 - 1. Provide AWI Premium quality standards.

2.2 WOOD CABINETS FOR TRANSPARENT FINISH

- A. Architectural Woodwork Standards Grade: Premium.
- B. Type of Construction: Frameless.
- C. Door and Drawer-Front Style: Flush overlay.
- D. Wood for Exposed Surfaces:
 - 1. Species: White maple, unless otherwise shown.
 - 2. Blueprint Matching: Comply with veneer and other matching requirements indicated for blueprint-matched paneling.
 - 3. Cut: Plain sliced.
 - 4. Grain Direction: Vertical.
 - 5. Matching of Veneer Leaves: Slip match.
 - 6. Veneer Matching within Panel Face: Running match.

7. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.

E. Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: Compatible species to that indicated for exposed surfaces, stained to match.
2. Drawer Subfronts, Backs, and Sides: Solid-hardwood lumber, same species indicated for exposed surfaces.
3. Drawer Bottoms: Hardwood plywood.

F. Dust Panels: 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers unless located directly under tops.

G. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners.

2.3 WOOD CABINETS FOR OPAQUE FINISH

A. Architectural Woodwork Standards Grade: Premium.

B. Type of Construction: Frameless.

C. Door and Drawer-Front Style: Flush overlay.

D. Species for Exposed Lumber Surfaces: Any closed-grain hardwood.

E. Panel Product for Exposed Surfaces: MDF.

F. Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: Match materials indicated for exposed surfaces.
2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Hardwood plywood.

G. Dust Panels: 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers unless located directly under tops.

H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners.

2.4 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches (75 mm) wide.
 2. Wood Moisture Content: 5 to 10 percent.

2.5 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of architectural cabinets.
- C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E84.
1. For panels 3/4 inch (19 mm) thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi (11 MPa); modulus of elasticity, 300,000 psi (2070 MPa); internal bond, 80 psi (550 kPa); and screw-holding capacity on face and edge, 250 and 225 lbf (1100 and 1000 N), respectively.
 2. For panels 13/16 to 1-1/4 inches (20 to 32 mm) thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi (9 MPa); modulus of elasticity, 250,000 psi (1720 MPa); linear expansion, 0.50 percent; and

screw-holding capacity on face and edge, 250 and 175 lbf (1100 and 780 N), respectively.

- D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E84.

2.6 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 71 00 "Door Hardware."
- B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 135 degrees of opening, self-closing.
- C. Wire Pulls: Doug Mockett. No. DP105/2 Series. Drawers: DP105A/2, Cabinets: DP105B/2. Matte chrome.
- D. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.
- E. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer.
 - a. Type: Full extension.
 - b. Material: Zinc-plated steel with polymer rollers.
 - 2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-overtravel-extension type; zinc-plated-steel, ball-bearing slides.
- F. Slides for Sliding Glass Doors: ANSI/BHMA A156.9, B07063; aluminum.
- G. Door Locks: ANSI/BHMA A156.11, E07121.
- H. Drawer Locks: ANSI/BHMA A156.11, E07041.
- I. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- J. Keyboard Tray: Humanscale "Swivel Mouse System."
- K. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.7 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.8 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate architectural cabinets to dimensions, profiles, and details indicated. Ease edges and corners to 1/16-inch (1.5-mm) radius unless otherwise indicated.
- C. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
 - 2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- D. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- E. Install glass to comply with applicable requirements in Section 08 80 00 "Glazing" and in GANA's "Glazing Manual."
 - 1. For glass in wood frames, secure glass with removable stops.
 - 2. For exposed glass edges, polish and grind smooth.

2.9 SHOP FINISHING

- A. General: Finish architectural cabinets at manufacturer's shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural cabinets, as applicable to each unit of work.
 - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of cabinets.
- C. Transparent Finish:
 - 1. Grade: Same as item to be finished.
 - 2. Finish: System - 11, catalyzed polyurethane.
 - 3. Staining: Match Architect's sample (Color to be selected by Architect from full range of colors).
 - 4. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
 - 5. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

D. Opaque Finish:

1. Architectural Woodwork Standards Grade: Premium.
2. Finish: System - 11, catalyzed polyurethane.
3. Color: As selected by Architect from manufacturer's full range.
4. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D523.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

- A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with cabinet surface.
1. For shop-finished items, use filler matching finish of items being installed.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm) using concealed shims.
1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 3. Maintain veneer sequence matching of cabinets with transparent finish.
 4. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch (38-mm) penetration into wood framing, blocking, or hanging strips.
- E. Shop Finishes: Touch up finishing after installation of architectural cabinets. Fill nail holes with matching filler.
1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.
- F. Field Finishing: See Section 09 91 23 "Interior Painting" for finishing of installed architectural cabinets.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces. Touch up finishes to restore damaged or soiled areas.

END OF SECTION 06 41 13

SECTION 06 41 16 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

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. Plastic-laminate-clad architectural cabinets.
2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.
2. Section 12 36 23.13 "Plastic-Laminate-Clad Countertops."

1.3 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.

4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.
 - D. Samples for Initial Selection: For each type of exposed finish.
 - E. Samples for Verification: For the following:
 1. Plastic Laminates: 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish required.
 - a. Provide one sample applied to core material with specified edge material applied to one edge.
 2. Thermoset Decorative Panels: 8 by 10 inches (200 by 250 mm), for each color, pattern, and surface finish.
 - a. Provide edge banding on one edge.
 3. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
 - B. Field quality-control reports.
- 1.7 QUALITY ASSURANCE
- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- 1.9 FIELD CONDITIONS
- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
 - B. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90

deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.

- C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
 - 1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. Architectural Woodwork Standards Grade: Premium.
- C. Type of Construction: Frameless.
- D. Door and Drawer-Front Style: Flush overlay.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
 - 1. Manufacturers:
 - a. Formica Corporation.
 - b. Nevamar Decorative Surfaces.
 - c. Wilsonart International; Div. of Premark International, Inc.
 - d. Equal product if approved by Architect in an addendum.
- F. Laminate Cladding for Exposed Surfaces:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Vertical Surfaces: Grade HGS.
 - 3. Edges: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
 - 4. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.

G. Materials for Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels.
 - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
3. Drawer Bottoms: Thermoset decorative panels.

H. Dust Panels: 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers unless located directly under tops.

I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners.

K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As selected by Architect from laminate manufacturer's full range.

2.2 WOOD MATERIALS IF SHOWN

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: 8 to 13 percent.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of architectural cabinets.
- C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E84.
1. For panels 3/4 inch (19 mm) thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi (11 MPa); modulus of elasticity, 300,000 psi (2070 MPa); internal bond, 80 psi (550 kPa); and screw-holding capacity on face and edge, 250 and 225 lbf (1100 and 1000 N), respectively.
 2. For panels 13/16 to 1-1/4 inches (20 to 32 mm) thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi (9 MPa); modulus of elasticity, 250,000 psi (1720 MPa); linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf (1100 and 780 N), respectively.
- D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E84.

2.4 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 71 11 "Door Hardware (Descriptive Specification)."
- B. Butt Hinges: 2-3/4-inch (70-mm), five-knuckle steel hinges made from 0.095-inch- (2.4-mm-) thick metal, and as follows:
1. Semic concealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.
- C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 135 degrees of opening, self-closing.
- D. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.
- E. Wire Pulls: Doug Mockett. No. DP105/2 Series. Drawers: DP105A/2, Cabinets: DP105B/2. Matte chrome.

- F. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.
- G. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer.
 - a. Type: Full extension.
 - b. Material: Zinc-plated steel with polymer rollers.
 - 2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-overtravel-extension type; zinc-plated-steel ball-bearing slides.
 - 3. For drawers not more than 3 inches (75 mm) high and not more than 24 inches (600 mm) wide, provide Grade 2.
 - 4. For drawers more than 3 inches (75 mm) high, but not more than 6 inches (150 mm) high and not more than 24 inches (600 mm) wide, provide Grade 1.
 - 5. For drawers more than 6 inches (150 mm) high or more than 24 inches (600 mm) wide, provide Grade 1HD-200.
 - 6. For computer keyboard shelves, provide Grade 1HD-200.
 - 7. For trash bins not more than 20 inches (500 mm) high and 16 inches (400 mm) wide, provide Grade 1HD-200.
- H. Slides for Sliding Glass Doors: ANSI/BHMA A156.9, B07063; aluminum.
- I. Door Locks: ANSI/BHMA A156.11, E07121.
- J. Drawer Locks: ANSI/BHMA A156.11, E07041.
- K. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- L. Grommets for Cable Passage: 2-inch (51-mm) OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
 - 1. Color: Black.
- M. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
 - 1. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.
- N. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.

2.6 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
 - 2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- D. Install glass to comply with applicable requirements in Section 08 80 00 "Glazing" and in GANA's "Glazing Manual."
 - 1. For glass in frames, secure glass with removable stops.
 - 2. For exposed glass edges, polish and grind smooth.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

- A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm) using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch (38-mm) penetration into wood framing, blocking, or hanging strips.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION 06 41 16

SECTION 07 14 16 - COLD FLUID-APPLIED WATERPROOFING

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. Polyurethane waterproofing.
- B. Related Requirements:
 - 1. Section 09 30 13 "Tiling" for fluid-applied waterproof membranes beneath tiles.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review waterproofing requirements including, but not limited to, the following:
 - a. Surface preparation specified in other Sections.
 - b. Minimum curing period.
 - c. Forecasted weather conditions.
 - d. Special details and sheet flashings.
 - e. Repairs.
 - f. Field quality control.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
 - 2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
- B. Shop Drawings:
 - 1. Show locations and extent of waterproofing.
 - 2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
 - 3. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

- C. Samples: For each exposed product and for each color and texture specified, including the following products:
 - 1. Flashing sheet, 8 by 8 inches (200 by 200 mm).
 - 2. Membrane-reinforcing fabric, 8 by 8 inches (200 by 200 mm).
 - 3. Drainage panel, 4 by 4 inches (100 by 100 mm).
 - 4. Plaza-deck paver, 4 by 4 inches (100 by 100 mm) square in each color and texture required.
 - 5. Paver pedestal assembly.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.
 - 1. Build mockup for each typical waterproofing installation including pavers and accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.
 - a. Size: 100 sq. ft. (9.3 sq. m) in area.
 - b. Description: Each type of installation.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.
 - 1. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
 - 2. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.
- B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.8 WARRANTY

- A. **Manufacturer's Special Warranty:** Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.

1. **Warranty Period:** Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Source Limitations for Waterproofing System:** Obtain waterproofing materials, protection course, from single source from single manufacturer.

2.2 SINGLE-COMPONENT POLYURETHANE WATERPROOFING

- A. **Single-Component, Modified Polyurethane Waterproofing:** ASTM C836/C836M and coal-tar free.

1. **Products:** Subject to compliance with requirements, provide one of the following:

- a. Anti-Hydro International, Inc; A-H Seamless Membrane.
- b. BASF Construction Chemicals, LLC, Building Systems; Sonoshield HLM 5000.
- c. Carlisle Coatings & Waterproofing Inc; CCW-525.
- d. CETCO; LDC 60.
- e. Neogard; Neogard 7401.
- f. Polyguard Products, Inc; Polyguard PG-250.
- g. Tremco Incorporated; TREMproof 250 GC.
- h. United Coatings; Elastall 1000.
- i. Equal product approved by Architect in an addendum.

2.3 PROTECTION COURSE

- A. **Protection Course:** ASTM D6506, semirigid sheets of fiberglass- or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:

1. **Thickness:** 1/8 inch (3 mm), nominal.
2. **Adhesive:** Rubber-based solvent type recommended in writing by waterproofing manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. **Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.**

1. **Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.**

2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D4263.

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

3.2 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
- D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.
 1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D4258.
- E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

- A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners according to waterproofing manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M.
- B. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

3.4 JOINT AND CRACK TREATMENT

- A. Prepare, treat, rout, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D4258.
 1. Comply with ASTM C1193 for joint-sealant installation.
 2. Apply bond breaker on sealant surface, beneath preparation strip.
 3. Prime substrate along each side of joint and apply a single thickness of preparation strip at least 6 inches (150 mm) wide along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.

- B. Install sheet flashing and bond to deck and wall substrates where required according to waterproofing manufacturer's written instructions.

3.5 WATERPROOFING APPLICATION

- A. Apply waterproofing according to manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M.
- B. Start installing waterproofing in presence of manufacturer's technical representative.
- C. Apply primer over prepared substrate unless otherwise instructed in writing by waterproofing manufacturer.
- D. Cure waterproofing, taking care to prevent contamination and damage during application and curing.
- E. Install protection course with butted joints over waterproofing before starting subsequent construction operations.
 - 1. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.

3.6 PROTECTION

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

END OF SECTION 07 14 16

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Foam-plastic Boards.
2. Sound Attenuation Board.
3. Glass-fiber blanket.
4. Mineral-wool blanket.
5. Spray-foam Polyurethane insulation.
6. Spray thermal barrier protective coating.

B. Related Requirements:

1. Section 04 20 00 "Unit Masonry" for insulation installed in masonry cells.
2. Section 07 27 26 "Fluid Applied Membrane Air Barriers" for water-resistive barrier applied over wall sheathing.
3. Section 07 54 23 "Thermoplastic-Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARDS

- A. Extruded Polystyrene Board: ASTM C578, Type X, 15-psi (104-kPa) minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E84.
 1. Manufacturers:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company.
 - c. Owens Corning.
 - d. Pactiv Building Products Division.
 2. Type IV, 25 psi (173 kPa).
- B. Polyisocyanurate Board, Glass-Fiber-Mat Faced: ASTM C 1289, glass-fiber-mat faced, Type II, Class 2.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Atlas Roofing Corporation; Rboard or comparable product approved by one of the following:
 - a. Firestone Building Products.
 - b. Hunter Panels.
- C. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

2.2 SOUND ATTENUATION BLANKET

- A. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

2.3 GLASS-FIBER BLANKET

- A. Glass-Fiber Blanket, Unfaced: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Guardian Building Products, Inc.

- b. Johns Manville; a Berkshire Hathaway company.
- c. Knauf Insulation.
- d. Owens Corning.

2.4 MINERAL-WOOL BLANKETS

- A. Mineral-Wool Blanket, Unfaced: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Industrial Insulation Group, LLC (IIG-LLC).
 - b. Roxul Inc.
 - c. Thermafiber, Inc.; an Owens Corning company.

2.5 SPRAY POLYURETHANE FOAM INSULATION

- A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation.
 - b. BaySystems NorthAmerica, LLC.
 - c. Dow Chemical Company (The).
 - d. ERSystems, Inc.
 - e. Gaco Western Inc.
 - f. Henry Company.
 - g. NCFI; Division of Barnhardt Mfg. Co.
 - h. SWD Urethane Company.
 - i. Volatile Free, Inc.
 - 2. Minimum density of 1.5 lb/cu. ft. (24 kg/cu. m), thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F (43 K x m/W at 24 deg C).

2.6 SPRAY THERMAL BARRIER PROTECTIVE COATING

- A. Spray Thermal Barrier Protective Coating: Total system encompassing coating that limits the average temperature rise of the unexposed surface to not more than 250 deg F (120 deg C) after 15 minutes of fire exposure, complying with the standard time-temperature curve of ASTM E 119 or UL 263.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation.

- b. Dow Chemical Company (The).
 - c. Gaco Western Inc.
 - d. International Cellulose Corporation; Ure-K Spray Coating.
 - e. NCFI; Division of Barnhardt Mfg. Co.
 - f. SWD Urethane Company.
2. Application Thickness: Minimum 1 inch (25 mm).

2.7 ACCESSORIES

- A. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
 1. Adhesives shall have a VOC content of 70 g/L or less.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 4 inches (610 mm) in from exterior walls.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
 2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
 4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.5 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face and as recommended by manufacturer.
 1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
 2. Press units firmly against inside substrates.
 3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 04 20 00 "Unit Masonry."
- B. Cellular-Glass Board Insulation: Install with closely fitting joints using adhesive pad attachment method according to manufacturer's written instructions.
- C. Mineral-Wool Board Insulation: Install insulation fasteners 4 inches (100 mm) from each corner of board insulation, at center of board, and as recommended by manufacturer.
 1. Fit courses of insulation between masonry wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
 2. Press units firmly against inside substrates.

3.6 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
 5. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 6. For wood-framed construction, install blankets according to ASTM C1320 and as follows:
 - a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
 7. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
 - a. Exterior Walls: Set units with facing placed toward as indicated on Drawings.
 - b. Interior Walls: Set units with facing placed as indicated on Drawings.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.
- C. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.7 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

SECTION 07 24 21 – DIRECT-APPLIED EXTERIOR FINISH SYSTEM (DEFS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. Base coat and finish system (DEFS) applied over metal framing and exterior cement board.

B. Related Sections:

- 1. Division 7 Section "Joint Sealants" for sealing joints in DEFS with elastomeric joint sealants.
- 2. Division 9 Section "Non-Structural Metal Framing" for framing components.

1.3 SYSTEM DESCRIPTION

- A. A non-load-bearing, exterior soffit cladding system that consists of a board substrate attached adhesively and mechanically to the framing; an integrally reinforced base coat; and a textured protective finish coat.

1.4 SUBMITTALS

- A. Product Data: For each type and component of DEFS indicated.
- B. Samples for Initial Selection: For each type of finish-coat color and texture indicated.
 - 1. Include similar Samples of joint sealants and exposed accessories.
- C. Compatibility and Adhesion Test Reports: For joint sealants from sealant manufacturer indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An installer who is qualified to install manufacturer's system using

trained workers.

- B. Source Limitations: Obtain DEFS from single source from single DEFS manufacturer and from sources approved by DEFS manufacturer as compatible with system components.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.
- B. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.

1.7 COORDINATION

- A. Coordinate installation of DEFS with related Work specified in other Sections to ensure that wall assemblies, including sheathing, flashing, trim, joint sealants, windows, and doors, are protected against damage from the effects of weather, age, corrosion, moisture, and other causes. Do not allow water to penetrate behind flashing and barrier coating of DEFS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Master Wall, Inc.
 2. Senergy; Degussa Wall Systems, Inc.
 3. Stuc-O-Flex International, Inc.
 4. Total Wall Inc.
 5. Dryvit, Inc.

2.2 MATERIALS

- A. Compatibility: Provide adhesive, fasteners, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates and approved for use by DEFS manufacturer for Project.
- B. Exterior Cement Board: Not less than 5/8" thick cement board complying with ASTM C 1186, Type A, for exterior applications.
 1. Fasteners: Flat, bugle-head steel drill screws complying with ASTM C 954, with an organic-polymer coating or other corrosion-protective coating having a salt-spray resistance of more than 500 hours per ASTM B 117.
 - a. Size and Length: As recommended by cement board manufacturer for type and thickness of cement board to be attached.

- C. Base coat: DEFS manufacturer's standard formulation designed for indicated use, compatible with substrate, and complying with the following:
 - 1. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, and polymer-based adhesive specified for base coat.
- D. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other DEFS materials, made from continuous multi-end strands with retained mesh tensile strength of not less than 120 lbf/in. (21 dN/cm) per ASTM E 2098; complying with ASTM D 578 and the following:
 - 1. Standard-Impact Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
 - 2. Strip Reinforcing Mesh: Not less than 3.75 oz./sq. yd. (127 g/sq. m).
- E. Base-Coat Materials: DEFS manufacturer's standard mixture complying with the following:
 - 1. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
- F. Finish-Coat Materials: DEFS manufacturer's standard acrylic-based coating with enhanced mildew resistance complying with the following:
 - 1. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.
 - 2. Colors: As selected by Architect from manufacturer's full range.
- G. Water: Potable.
- H. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with DEFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard Cell Class for use intended, and ASTM C 1063.
 - 1. Casing Bead: Prefabricated, one-piece type for attachment to cement board, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
 - 2. Expansion Joint: Prefabricated, one-piece V profile; designed to relieve stress of movement.
 - 3. Corner Bead.
 - 4. Vent strip/bead.

2.3 MIXING

- A. General: Comply with DEFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as recommended by DEFS manufacturer. Mix materials in clean containers. Use materials within time period specified by DEFS manufacturer or discard.

2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified

in this Article for material and manufacture.

1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- B. Power-Driven Fasteners: NES NER-272.
- C. Screws for Fastening Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
1. For steel framing less than 0.0329 inch (0.835 mm) thick, attach sheathing to comply with ASTM C 1002.
 2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, attach sheathing to comply with ASTM C 954.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of DEFS.
- B. Examine wall framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where DEFS will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
 1. Begin coating application only after surfaces are dry.
 2. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Protect contiguous work from moisture deterioration and soiling caused by application of DEFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.
- B. Protect DEFS, substrates, and soffit construction behind them from inclement weather during installation. Prevent penetration of moisture behind DEFS and deterioration of substrates.
- C. Prepare and clean substrates to comply with DEFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

3.3 EXTERIOR CEMENT-BOARD INSTALLATION

- A. Exterior Cement Board: Install on metal framing to comply with cement-board manufacturer's written instructions and evaluation report acceptable to authorities having jurisdiction. Install board with construction adhesive on all framing members and steel drill screws spaced no more

than 8 inches (203 mm) o.c. along framing with perimeter fasteners at least 3/8 inch (9.6 mm) but less than 5/8 inch (15.9 mm) from edges of boards.

3.4 TRIM INSTALLATION

- A. Trim: Apply trim accessories at perimeter of DEFS, at expansion joints, at outside corners, dissimilar surfaces and elsewhere as indicated, according to DEFS manufacturer's written instructions.
 - 1. Expansion Joint: Use where needed according to DEFS manufacturer's recommendations.
 - 2. Casing Bead: Use at other locations.
 - 3. Corner Bead: Use at all outside corners.
 - 4. Starter track: Use where indicated according to DEFS manufacturer's recommendations.
 - 5. Continuous vent bead.

3.5 BASE-COAT INSTALLATION

- A. Double Base-Coat Application: Apply second base coat in same manner and thickness as first application except without reinforcing mesh. Do not apply until first base coat has cured.
- B. Reinforcing Mesh: Apply reinforcing mesh over entire sheet with basecoat application to produce wrinkle-free installation.
 - 1. Standard-impact reinforcing mesh.
- C. Additional Reinforcing Mesh: Apply strip reinforcing mesh around openings extending 4 inches (100 mm) beyond perimeter. Apply additional 9-by-12-inch (230-by-300-mm) strip reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch- (200- mm-) wide strip reinforcing mesh at inside unless base layer of mesh is lapped not less than 4 inches (100 mm) on each side of corners.
 - 1. Embed strip reinforcing mesh in base coat before applying first layer of reinforcing mesh.

3.6 FINISH-COAT INSTALLATION

- A. Finish Coat: Apply over dry base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by DEFS manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
 - 1. Texture: As selected by Architect from manufacturer's full range.

3.7 CLEANING AND PROTECTION

- A. Remove temporary covering and protection of other work. Promptly remove coating materials from window and doorframes and other surfaces outside areas indicated to receive DEFS coatings.

END OF SECTION 07 24 21

SECTION 07 27 26 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Fluid-applied membrane air barrier, vapor retarding and vapor-permeable.

B. Related Sections include the following:

1. Section 04 20 00 "Unit Masonry" for embedded flashings.
2. Section 06 16 00 "Sheathing" for wall sheathings, wall sheathing joint-and-penetration treatments.
3. Section 07 62 00 "Sheet Metal Flashing and Trim" for sheet metal flashings.
4. Section 07 92 00 "Joint Sealants" for joint-sealant materials and installation.

1.2 DEFINITIONS

A. ABAA: Air Barrier Association of America.

B. Air Barrier Assembly: The collection of air barrier materials and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.3 PERFORMANCE REQUIREMENTS

A. General: Air barrier shall be capable of performing as a continuous vapor-retarding air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of air barrier.

B. Shop Drawings: Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1. Include details of interfaces with other materials that form part of air barrier.
2. Include details of mockups.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Mockups: Before beginning installation of air barrier, build mockups of exterior wall assembly, 150 sq. ft. (14 sq. m), incorporating backup wall construction, external cladding, window, door frame and sill, insulation, and flashing to demonstrate surface preparation, crack and joint treatment, and sealing of gaps, terminations, and penetrations of air barrier membrane.
 - 1. Coordinate construction of mockup to permit inspection by Owner's testing agency of air barrier before external insulation and cladding is installed.
 - 2. Include junction building corner condition and foundation wall intersection.
 - 3. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 - 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Preinstallation Conference: Conduct conference at Project site.
 - 1. Include installers of other construction connecting to air barrier, including roofing, waterproofing, architectural precast concrete, masonry, sealants, windows, glazed curtain walls, and door frames.
 - 2. Review air barrier requirements including surface preparation, substrate condition and pretreatment, minimum substrate curing period, forecasted weather conditions, special details and sheet flashings, mockups, installation procedures, sequence of installation, testing and inspecting procedures, and protection and repairs.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by air barrier manufacturer.
- B. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- C. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air barrier manufacturer. Protect substrates from environmental conditions that affect performance of air barrier. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

- B. VOC Content: 250 g/L or less.

2.2 FLUID-APPLIED MEMBRANE AIR BARRIER

- A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: synthetic polymer membrane.

- 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Synthetic Polymer Membrane:

- 1) Carlisle Coatings & Waterproofing Inc.; Barritech VP.
- 2) Henry Company; Air-Bloc 31.
- 3) Grace, W. R. & Co.; Perm-A-Barrier VP Liquid.

- 2. Physical and Performance Properties:

- a. Membrane Air Permeance: Not to exceed 0.004 cfm/ sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E 2178.
- b. Membrane Vapor Permeance: Not less than 10 perms (580 ng/Pa x s x sq. m); ASTM E 96.

- B. Fluid-Applied, Vapor-Retarding Membrane Air Barrier: synthetic polymer membrane.

- 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Synthetic Polymer Membrane:

- 1) Grace, W. R. & Co.; Perm-A-Barrier Liquid.
- 2) Henry Company; Air-Bloc 21 or 21S.
- 3) Rubber Polymer Corporation; Rub-R-Wall Airtight.

2. Physical and Performance Properties:
 - a. Membrane Air Permeance: Not to exceed 0.004 cfm x sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E 2178.
 - b. Membrane Vapor Permeance: Not to exceed 0.1 perm (5.8 ng/Pa x s x sq. m); ASTM E 96.

2.3 AUXILIARY MATERIALS

- A. General: Auxiliary materials recommended by air barrier manufacturer for intended use and compatible with air barrier membrane. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid waterborne primer recommended for substrate by manufacturer of air barrier material.
- C. Counterflashing Strip: Modified bituminous, 40-mil- (1.0-mm-) thick, self-adhering sheet consisting of 32 mils (0.8 mm) of rubberized asphalt laminated to an 8-mil- (0.2-mm-) thick, crosslaminated polyethylene film with release liner backing.
- D. Modified Bituminous Strip: Vapor-retarding, 40-mil- (1.0-mm-) thick, smooth-surfaced, self-adhering; consisting of 36 mils (0.9 mm) of rubberized asphalt laminated to a 4-mil- (0.1-mm-) thick polyethylene film with release liner backing.
- E. Joint Reinforcing Strip: Air barrier manufacturer's glass-fiber-mesh tape.
- F. Substrate Patching Membrane: Manufacturer's standard trowel-grade substrate filler.
- G. Adhesive and Tape: Air barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.
- H. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.0187 inch (0.5 mm) thick, and Series 300 stainless-steel fasteners.
- I. Sprayed Polyurethane Foam Sealant: 1- or 2-component, foamed-in-place, polyurethane foam sealant, 1.5 to 2.0 lb/cu. ft (24 to 32 kg/cu. m) density; flame spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.
- J. Elastomeric Flashing Sheet: ASTM D 2000, 2BC415 to 3BC620, minimum 50- to 65-mil- (1.3- to 1.6-mm-) thick, cured sheet neoprene with manufacturer's recommended contact adhesives and lap sealant with stainless-steel termination bars and fasteners.
- K. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low-modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that concrete has cured and aged for minimum time period recommended by air barrier manufacturer.
 - 3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 4. Verify that masonry joints are flush and completely filled with mortar.
 - 5. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 JOINT TREATMENT

- A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
 - 1. Prime substrate and apply a single thickness of air-barrier manufacturer's recommended preparation coat extending a minimum of 3 inches (75 mm) along each side of joints and cracks. Apply a double thickness of fluid air-barrier material and embed a joint reinforcing strip in preparation coat.
- B. Gypsum Sheathing: Fill joints greater than 1/4 inch (6 mm) with sealant according to ASTM

C 1193 and with air barrier manufacturer's written instructions. Apply first layer of fluid air barrier membrane at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air barrier membrane over joint reinforcing strip.

3.4 TRANSITION STRIP INSTALLATION

- A. Install strips, transition strips, and auxiliary materials according to air barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
- B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.
 - 1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Connect and seal exterior wall air barrier membrane continuously to roofing membrane air barrier, concrete below-grade structures, floor-to floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- E. Apply joint sealants forming part of air barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- F. Wall Openings: Prime concealed perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply elastomeric flashing sheet so that a minimum of 3 inches (75 mm) of coverage is achieved over both substrates. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames with not less than 1 inch (25 mm) of full contact.
 - 1. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches (150 mm) o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
- G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air barrier membrane with foam sealant.
- H. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- I. Seal top of through-wall flashings to air barrier with an additional 6-inch- (150-mm-) wide, counterflashing strip.
- J. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- K. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond

repaired areas in strip direction.

3.5 AIR BARRIER MEMBRANE INSTALLATION

- A. Apply air barrier membrane to form a seal with strips and transition strips and to achieve a continuous air barrier according to air barrier manufacturer's written instructions.
- B. Apply air barrier membrane within manufacturer's recommended application temperature ranges.
- C. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.
 - 1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- D. Apply a continuous unbroken air barrier to substrates according to the following minimum thickness. Apply membrane in full contact around protrusions such as masonry ties.
 - 1. Vapor-Retarding Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 40-mil (1.0-mm) dry film thickness.
 - 2. Vapor-Permeable Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 40-mil (1.0-mm) dry film thickness.
- E. Apply strip and transition strip a minimum of 1 inch (25 mm) onto cured air membrane or strip and transition strip over cured air membrane overlapping 3 inches (75 mm) onto each surface according to air barrier manufacturer's written instructions.
- F. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.
- G. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.

3.6 CLEANING AND PROTECTION

- A. Protect air barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
 - 1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace air barrier exposed for more than 60 days.
 - 2. Protect air barrier from contact with creosote, uncured coal-tar products, TPO, EPDM, flexible PVC membranes, and sealants not approved by air barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- C. Remove masking materials after installation.

END OF SECTION 07 27 26

SECTION 07 31 13 - ASPHALT SHINGLES

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. Asphalt shingles.
 - 2. Underlayment.

1.3 DEFINITION

- A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.
 - 1. Asphalt Shingles: Full size.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For asphalt shingles to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Asphalt Shingles: 100 sq. ft. (9.3 sq. m) of each type, in unbroken bundles.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store roofing materials in a dry, well-ventilated location protected from weather, sunlight, and moisture according to manufacturer's written instructions.
- B. Store underlayment rolls on end on pallets or other raised surfaces. Do not double stack rolls.
- C. Protect unused roofing materials from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.
- D. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Install self-adhering sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace asphalt shingles that fail within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Manufacturing defects.
 - 2. Material Warranty Period: 20 years from date of Substantial Completion, prorated, with first five years nonprorated.
 - 3. Wind-Speed Warranty Period: Asphalt shingles will resist blow-off or damage caused by wind speeds of up to 90 mph for 20 years from date of Substantial Completion.
 - 4. Algae-Resistance Warranty Period: Asphalt shingles will not discolor for 20 years from date of Substantial Completion.
 - 5. Workmanship Warranty Period: 20 years from date of Substantial Completion.
- B. Roofing Installer's Warranty: On warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of asphalt-shingle roofing that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Exterior Fire-Test Exposure: Provide asphalt shingles and related roofing materials identical to those of assemblies tested for Class A fire resistance according to ASTM E 108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

2.2 GLASS-FIBER-REINFORCED ARCHITECTURAL ASPHALT SHINGLES

- A. Laminated-Strip Asphalt Shingles: ASTM D 3462/D 3462M, laminated, multi-ply overlay construction, glass-fiber reinforced, mineral-granule surfaced, and self-sealing.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. TAMKO Building Products, Inc.
 - 2. Butt Edge: Straight cut.
 - 3. Strip Size: Manufacturer's standard.
 - 4. Algae Resistance: Granules resist algae discoloration.
 - 5. Impact Resistance: UL 2218, Class 4.
 - 6. Color and Blends: As selected by Architect from manufacturer's full range.
- B. Hip and Ridge Shingles: Manufacturer's standard units to match asphalt shingles.

2.3 UNDERLAYMENT MATERIALS

- A. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; evaluated and documented to be suitable for use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. TAMKO Building Products, Inc.
- B. Granular-Surfaced Valley Lining: ASTM D 6380, Class M, organic-felt-based, asphalt roll roofing; 36 inches (914 mm) wide.

2.4 ACCESSORIES

- A. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
- B. Roofing Nails: ASTM F 1667; aluminum, stainless-steel, copper, or hot-dip galvanized-steel wire shingle nails, minimum 0.120-inch- (3-mm-) diameter, sharp-pointed, with a minimum 3/8-inch- (9.5-mm-) diameter flat head and of sufficient length to penetrate 3/4 inch (19 mm) into solid wood decking or extend at least 1/8 inch (3 mm) through OSB or plywood sheathing.
 - 1. Shank: Barbed.
 - 2. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
- C. Synthetic-Underlayment Fasteners: As recommended in writing by synthetic-underlayment manufacturer for application indicated.

2.5 METAL FLASHING AND TRIM

- A. General: Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored; and that provisions have been made for flashings and penetrations through asphalt shingles.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
- B. Synthetic Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides and ends and treat laps as recommended in writing by manufacturer. Stagger end laps between succeeding courses at interval recommended in writing by manufacturer. Fasten according to manufacturer's written instructions. Cover underlayment within period recommended in writing by manufacturer.
 - 1. Install in single layer on roofs sloped at 4:12 and greater.
 - 2. Install in double layer on roofs sloped at less than 4:12.
- C. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install lapped in direction that sheds water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Roll laps with roller. Cover underlayment within seven days.
 - 1. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
 - 2. Eaves: Extend from edges of eaves 24 inches (600 mm) beyond interior face of exterior wall.
 - 3. Valleys: Extend from lowest to highest point 18 inches (450 mm) on each side.
 - 4. Hips: Extend 18 inches (450 mm) on each side.
 - 5. Ridges: Extend 36 inches (914 mm) on each side.
 - 6. Sidewalls: Extend beyond sidewall 18 inches (450 mm), and return vertically against sidewall not less than 4 inches (100 mm).
 - 7. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend beyond penetrating element 18 inches (450 mm), and return vertically against penetrating element not less than 4 inches (100 mm).
 - 8. Roof Slope Transitions: Extend 18 inches (450 mm) on each roof slope.

- D. Concealed Valley Lining: For woven valleys. Comply with NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems." Install underlayment centered in valley and fastened to roof deck.
 - 1. Lap roof-deck underlayment over valley underlayment at least 6 inches (150 mm).

3.3 METAL FLASHING INSTALLATION

- A. General: Install metal flashings and other sheet metal to comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."
 - 1. Install metal flashings according to recommendations in ARMA's "Residential Asphalt Roofing Manual" and NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."
- B. Apron Flashings: Extend lower flange over and beyond each side of downslope asphalt shingles and up the vertical surface.
- C. Step Flashings: Install with a headlap of 2 inches (50 mm) and extend over the underlying asphalt shingle and up the vertical surface. Fasten to roof deck only.
- D. Cricket or Backer Flashings: Install against the roof-penetrating element extending concealed flange beneath upslope asphalt shingles and beyond each side.
- E. Open-Valley Flashings: Install centered in valleys, lapping ends at least 8 inches (200 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
 - 1. Secure hemmed flange edges into metal cleats spaced 12 inches (300 mm) apart and fastened to roof deck.
 - 2. Adhere 9-inch- (225-mm-) wide strip of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
- F. Rake Drip Edges: Install rake drip-edge flashings over underlayment and fasten to roof deck.
- G. Eave Drip Edges: Install eave drip-edge flashings below underlayment and fasten to roof sheathing.
- H. Pipe Flashings: Form flashing around pipe penetrations and asphalt shingles. Fasten and seal to asphalt shingles as recommended by manufacturer.

3.4 ASPHALT-SHINGLE INSTALLATION

- A. General: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and recommendations in NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."
- B. Install starter strip along lowest roof edge, consisting of an asphalt-shingle strip with tabs removed with self-sealing strip face up at roof edge.
 - 1. Extend asphalt shingles 1/2 inch (13 mm) over fasciae at eaves and rakes.
 - 2. Install starter strip along rake edge.

- C. Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
- D. Install asphalt shingles by single-strip column or racking method, maintaining uniform exposure. Install full-length first course followed by cut second course, repeating alternating pattern in succeeding courses.
- E. Woven Valleys: Extend succeeding asphalt-shingle courses from both sides of valley 12 inches (300 mm) beyond center of valley, weaving intersecting shingle-strip courses over each other. Use one-piece shingle strips without joints in valley.
 - 1. Do not nail asphalt shingles within 6 inches (150 mm) of valley center.

3.5 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS <Insert name> of <Insert address>, herein called the "Roofing Installer," has performed roofing and associated work ("the work") on the following project:
 - 1. Owner: <Insert name of Owner>.
 - 2. Address: <Insert address>.
 - 3. Building Name/Type: <Insert information>.
 - 4. Address: <Insert address>.
 - 5. Area of the Work: <Insert information>.
 - 6. Acceptance Date: <Insert date>.
 - 7. Warranty Period: <Insert time>.
 - 8. Expiration Date: <Insert date>.
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant the work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of the work as are necessary to correct faulty and defective work and as are necessary to maintain the work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
 - 1. Specifically excluded from this Warranty are damages to the work and other parts of the building, and to building contents, caused by:
 - a. Lightning;
 - b. Peak gust wind speed exceeding 90 mph;
 - c. Fire;
 - d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. Faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. Vapor condensation on bottom of roofing; and
 - g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When the work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to the work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of the work.
4. During Warranty Period, if Owner allows alteration of the work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of the alterations, but only to the extent the alterations affect the work covered by this Warranty. If Owner engages Roofing Installer to perform the alterations, Warranty shall not become null and void unless Roofing Installer, before starting the alterations, notified Owner in writing, showing reasonable cause for claim, that the alterations would likely damage or deteriorate the work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a use or service more severe than originally specified, this Warranty shall become null and void on date of the change, but only to the extent the change affects the work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect the work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on the work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of the work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this <Insert day> day of <Insert month>, <Insert year>.

1. Authorized Signature: <Insert signature>.
2. Name: <Insert name>.
3. Title: <Insert title>.

END OF SECTION 07 31 13

SECTION 07 41 13 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes standing-seam metal roof panels.
- B. Related Sections:
 - 1. Section 07 72 53 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 5. Review structural loading limitations of deck, purlins, and rafters during and after roofing.
 - 6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
 - 7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 - 8. Review temporary protection requirements for metal panel systems during and after installation.
 - 9. Review procedures for repair of metal panels damaged after installation.
 - 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical roof area and eave, including fascia, and soffit as shown on Drawings; approximately 48 inches (1200 mm) square by full thickness, including attachments, underlayment, and accessories.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 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 during installation.
- E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.9 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.

1.10 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.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 2. Warranty Period: Two years from date of Substantial Completion.
- B. 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 D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 30 years from date of Substantial Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
1. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for steep-slope roof products.
- B. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:
1. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than.
 2. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E1980.
- C. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- D. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E1680 or ASTM E283 at the following test-pressure difference:
1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).
- E. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:
1. Test-Pressure Difference: 2.86 lbf/sq. ft. (137 Pa).
- F. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.
- G. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
1. Uplift Rating: UL 30.

- H. FM Global Listing, if required: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
 - 1. Fire/Windstorm Classification: Class 1A-90.
 - 2. Hail Resistance: SH.
- I. 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

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 E1514.
 - 2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1637.
- B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced 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. Manufacturers:
 - a. AEP
 - b. Berridge
 - c. Centria
 - d. Fabral
 - e. Ryerson Tull
 - f. Equal approved by Architect in an addendum.
 - 2. Aluminum Sheet: Coil-coated sheet, ASTM B209 (ASTM B209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
 - a. Thickness: 0.040 inch (1.02 mm).
 - b. Surface: Smooth, flat finish.
 - c. Exterior Finish: Three-coat fluoropolymer.
 - d. Color: As selected by Architect from manufacturer's full range.
 - 3. Panel Coverage: 10 inches (254 mm)
 - 4. Panel Height: 1.5 inches (38 mm).

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils (0.76 mm) 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 (116 deg C); ASTM D1970.
 - 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D1970.
- B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) 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.
 - 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- 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- (2400-mm-) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (914 mm) 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- (3-m-) 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: Self-tapping screws designed to withstand design loads.

- G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 - 2. Joint Sealant: ASTM C920; elastomeric polyurethane or 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.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

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 UL-certified, 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. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. 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. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. 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. Aluminum Panels and Accessories:
 - 1. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. 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 C754 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 (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.

B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07 62 00 "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.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-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 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 sealant.
4. Watertight Installation:

- a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
- 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, closure strips, 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. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- 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 (914 mm) 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 (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.
1. Connect downspouts to underground drainage system indicated.
- J. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.7 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 07 41 13

SECTION 07 42 13 - METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Foamed-insulation-core metal wall panels for wall and soffit locations.
2. Concealed-fastener, lap-seam metal wall panels.
3. Metal composite material wall panels.

B. Related Sections:

1. Division 05 Section "Cold-Formed Metal Framing" for support framing, including girts, studs, and bracing.
2. Division 6 Section "Sheathing" for exterior sheathing.
3. Division 7 "Fluid-Applied Membrane Air Barriers".

1.3 DEFINITIONS

- A. Metal Wall Panel Assembly: Metal wall panels, attachment system components, miscellaneous metal framing, and miscellaneous accessories necessary for a complete weathertight wall system.

1.4 PERFORMANCE REQUIREMENTS

- A. General Performance: Metal wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at the following test-pressure difference:
 1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).

- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- D. Water Penetration under Dynamic Pressure: No evidence of water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. (299 Pa) and not more than 12 lbf/sq. ft. (575 Pa).
 - 1. Water Leakage: Uncontrolled water infiltrating the system or appearing on system's normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
- E. Structural Performance: Metal wall panel assemblies shall withstand the effects the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
 - 1. Wind Loads: Determine loads based on the following minimum design wind pressures:
 - a. Uniform pressure as indicated on Drawings.
 - 2. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/240 of the span.
- F. 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- G. Thermal Performance: Provide insulated metal wall panel assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 518.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of wall panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop-, and field-assembled work.
 - 1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:10):
 - a. Flashing and trim.

- b. Anchorage systems.
 - C. Samples for Initial Selection: For each type of metal wall panel indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.
 - 2. Include manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each sealant exposed to view.
 - D. Coordination Drawings: Exterior elevations, drawn to scale, and coordinating penetrations and wall-mounted items. Show the following:
 - 1. Wall panels and attachments.
 - 2. Stud framing.
 - 3. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
 - 4. Penetrations of wall by pipes and utilities.
 - E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
 - F. Field quality-control reports.
 - G. Maintenance Data: For insulated-core metal wall panels to include in maintenance manuals.
 - H. Warranties: Sample of special warranties.
- 1.6 QUALITY ASSURANCE
- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 - B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
 - C. Source Limitations: Obtain each type of metal wall panel from single source from a single manufacturer.
 - D. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, metal wall panel Installer, metal wall panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal wall panels, including installers of doors, windows, and louvers.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal wall panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
 - 6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 - 7. Review temporary protection requirements for metal wall panel assembly during and after installation.

8. Review wall panel observation and repair procedures after metal wall panel installation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
- B. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal wall panels for period of metal wall panel installation.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication, and indicate measurements on Shop Drawings.

1.9 COORDINATION

- A. Coordinate metal wall panel assemblies with rain drainage work, flashing, trim, and construction of girts, studs, soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall 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, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

- A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A 755/A 755M.
 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
 2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
 3. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
 4. Surface: Smooth, flat finish.
 5. Exposed Coil-Coated Finish: Two-coat flouropolymer, color as indicated.
 6. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
- B. Panel Sealants:
 1. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
 2. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.2 INSULATION FOR PANEL CORES

- A. Polyisocyanurate Insulation: Closed cell, modified polyisocyanurate foam using a non-CFC blowing agent, foamed-in-place type or board type, with maximum flame-spread index of 25 and smoke-developed index of 450.
 1. Closed-Cell Content: 90 percent when tested according to ASTM D 2856.

2.3 MISCELLANEOUS METAL FRAMING

- A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.

- B. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch (1.63-mm) nominal thickness.
- C. Zee Clips: 0.079-inch (2.01-mm) nominal thickness.
- D. Hat-Shaped, Rigid Furring Channels:
 - 1. Nominal Thickness: Minimum 20 guage.
 - 2. Depth: As indicated.
- E. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.
 - 1. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with 0.040-inch (1.02-mm) nominal thickness.
 - 2. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.57-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.
- F. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), and depth required to fit insulation thickness indicated.
 - 1. Nominal Thickness: 0.025 inch (0.64 mm).
- G. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

2.4 MISCELLANEOUS MATERIALS

- A. Panel Fasteners: Self-tapping screws; bolts and nuts; self-locking rivets and bolts; end-welded studs; and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.
- B. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
- C. Panel Sealants: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal composite material panels and remain weathertight; and as recommended in writing by metal composite material panel manufacturer.

2.5 FOAMED-INSULATION-CORE METAL WALL PANELS

- A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
 - 1. Panel Performance:

- a. Flatwise Tensile Strength: 30 psi (207 kPa) when tested according to ASTM C 297.
 - b. Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for 7 days at 140 deg F (60 deg C) and 100 percent relative humidity according to ASTM D 2126.
 - c. Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at 200 deg F (93 deg C) according to ASTM D 2126.
 - d. Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at minus 20 deg F (29 deg C) according to ASTM D 2126.
 - e. Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.
 - f. Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.
2. Polyisocyanurate Insulation-Core Performance:
- a. Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D 1622.
 - b. Compressive Strength: Minimum 20 psi (138 kPa) when tested according to ASTM D 1621.
 - c. Shear Strength: 26 psi (179 kPa) when tested according to ASTM C 273.
- B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
1. Basis-of-Design Product: Subject to compliance with requirements, provide CENTRIA Architectural Systems; Formawall Dimension Series or comparable product by one of the following:
 - a. Benchmark Architectural Systems, Inc.; Designwall 4000
 - b. Metl-Span; CF Architectural Wall Panel.
 2. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
 - a. Material: Zinc-coated (galvanized) steel sheet:
 - 1) Exterior: 22 gauge nominal thickness.
 - 2) Interior: 26 gauge nominal thickness.
 - b. Exterior Facing Finish: As selected by Architect from manufacturer's full range (Terra Cotta Red).
 - c. Interior Facing Finish: Manufacturer's standard.
 - d. Exterior Surface: Smooth (embossed texture not acceptable).
 3. Panel Coverage: As indicated.
 4. Panel Thickness: 3.0 inches (76 mm).

2.6 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

A. General: Provide factory-formed metal panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

B. Rib-Profile, Concealed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Alcoa Architectural Products (USA); 4HC.
- b. ATAS International, Inc; ATAS Rigid Wall MFR160.
- c. MBCI; Masterline 16.
- d. Morin - A Kingspan Group Company; X-16.

2. Material: Zinc-coated (galvanized) steel sheet or coil-coated aluminum sheet.

- a. Nominal Thickness: 0.040 inch (1.02 mm).
- b. Surface: Smooth, flat finish.
- c. Color: Match Valspar High Performance Architectural Coatings; Dove Gray 432R 1021 (Coil).

3. Panel Coverage: 16 inches (457 mm).

4. Panel Height: 0.875 inch (22 mm).

2.7 METAL COMPOSITE MATERIAL WALL PANELS

A. Metal Composite Material Wall Panel Systems: Provide factory-formed and -assembled, metal composite material wall panels fabricated from two metal facings that are bonded to a solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment assembly components, and accessories required for weathertight system.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Alcoa Architectural Products (USA); Reynobond PE.
- b. Alumawall; Alumawall 1400 Series
- c. ALUCOBOND; 3A Composites USA, Inc; Alucobond PE.
- d. CENTRIA Architectural Systems; Formabond II Wall System.
- e. Mitsubishi Plastics Composites America; Alpolic.

B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch- (0.50-mm-) thick, coil-coated aluminum sheet facings.

1. Panel Thickness: 0.157 inch (4 mm).

2. Core: Standard.

3. Profile: As indicated on Drawings.

4. Color: Match Valspar High Performance Architectural Coatings; Dove Gray 432R 1021 (Coil).

C. Attachment Assembly Components: Formed from extruded aluminum.

- D. Attachment Assembly: Manufacturer's standard.

2.8 ACCESSORIES

- A. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
 - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 - 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
 - 4. Expansion Joint Filler: Manufacturer's flexible expansion joint filler.
 - 5. Sealants: Color to be selected by the Architect from manufacturer's standard panel color sealants.
- B. Flashing and Trim: Formed from 18 gauge (1.19-mm-) minimum thickness material matching wall panel. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, caps, sills, jambs, corners, endwalls, framed openings, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

2.9 FABRICATION

- A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, 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. Fabricate metal wall panels in a manner with joints between panels designed to form weathertight seals.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.
- E. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the 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 non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.10 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.11 ALUMINUM FINISHES

- A. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of work.
 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
 3. Verify that weather-resistant barrier has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
 4. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

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

3.2 PREPARATION

- A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages according to ASTM C 754 and metal wall panel manufacturer's written recommendations.
 - 1. Soffit Framing: Wire-tie furring channels to supports.

3.3 METAL WALL PANEL INSTALLATION, GENERAL

- A. General: Install metal wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Commence metal wall panel installation and install minimum of 300 sq. ft. (27.9 sq. m.) in presence of factory-authorized representative.
 - 2. Shim or otherwise plumb substrates receiving metal wall panels.
 - 3. Flash and seal metal wall panels with weather closures at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
 - 4. Install screw fasteners in predrilled holes.
 - 5. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 6. Install flashing and trim as metal wall panel work proceeds.
 - 7. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 8. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
 - 9. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 - 10. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
- B. Fasteners:
 - 1. Steel Wall 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 aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.
 - 1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
 - 2. Prepare joints and apply sealants to comply with requirements in Division 7 Section

"Joint Sealants."

3.4 INSULATED-CORE METAL WALL PANEL INSTALLATION

- A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated-core metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
1. Fasten insulated-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
 2. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 4. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
 5. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
- B. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.
1. Install clips to supports with self-tapping fasteners.

3.5 METAL COMPOSITE MATERIAL PANEL INSTALLATION

- A. General: Install metal composite material panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor metal composite material 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 composite material panels.
 2. Flash and seal metal composite material panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal composite material panels are installed.
 3. Install screw fasteners in predrilled holes.
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Install flashing and trim as metal composite material panel work proceeds.
 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 7. Align bottoms of metal composite material panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect

against galvanic action as recommended in writing by metal composite material panel manufacturer.

- D. Attachment Assembly, General: Install attachment assembly required to support metal composite material wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
 - 1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
- E. Installation: Attach metal composite material wall panels to supports at locations, spacings, and with fasteners recommended by manufacturer to achieve performance requirements specified.
 - 1. Wet Seal Systems: Seal horizontal and vertical joints between adjacent metal composite material wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Section 07 92 00 "Joint Sealants."
- F. Installation Tolerances: Shim and align metal composite material wall panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- G. 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 composite material panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal composite material panel manufacturer; or, if not indicated, provide types recommended in writing by metal composite material panel manufacturer.

3.6 ACCESSORY INSTALLATION

- A. General: 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 wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. 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 excessive oil canning, 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 to result in waterproof and weather-resistant performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic

sealant (concealed within joints).

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Water Penetration: Contractor to test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by SEI/ASCE 7, but not less than 6.24 lbf/sq. ft. (299 Pa).
- C. Water-Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of metal wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by Architect.
- D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect and test completed metal wall panel installation, including accessories.
- E. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
- F. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
- B. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 13

SECTION 07 54 23 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Adhered thermoplastic polyolefin (TPO) roofing system.
 - 2. Roof insulation, mechanically fastened.
 - 3. Cover board adhered.
- B. Related Requirements:
 - 1. Section 07 62 00 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
 - 2. Section 07 92 00 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.4 PREINSTALLATION MEETINGS

- A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - 3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
 - 5. Review structural loading limitations of roof deck during and after roofing.
 - 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
 - 7. Review governing regulations and requirements for insurance and certificates if applicable.

8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:
 1. Base flashings and membrane terminations.
 2. Tapered insulation, including slopes.
 3. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- C. Samples for Verification: For the following products:
 1. Sheet roofing, of color required.
 2. Walkway pads or rolls, of color required.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article. Provide documentation that all products within the roofing system are produced in Manufacturers own facilities for a minimum of 20 years.
 1. Submit evidence of compliance with performance requirements.
- B. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- D. Field quality-control reports.
- E. Sample Warranty: For installer.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is for roofing system identical to that used for this Project. Provide documentation that all products within the roofing system are produced in Manufacturers own facilities for a minimum of 20 years.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty. Contractor to document 10 years and 50 installations of systems similar to those specified below.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Special warranty includes roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, Metal Edges and other components of roofing system.
 - 2. Warranty Period: 20 years from date of Substantial Completion. 72 MPH wind speed
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain components including roof insulation, cover boards, fasteners, Adhesives and Metal Edges for roofing system from same manufacturer as membrane roofing
- B. Basis of Design: Versico Roofing Systems

1. Also Acceptable:
 - a. Carlisle
 - b. Firestone

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
 1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
 2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
- C. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.3 TPO ROOFING

- A. Fabric-Reinforced TPO Sheet: ASTM D 6878, internally fabric- or scrim-reinforced, uniform, flexible TPO sheet.
 1. Thickness: 80 Mil
 2. Exposed Face: Selected by Architect.

2.4 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as TPO sheet.
- C. Bonding Adhesive: Manufacturer's standard.
- D. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
- E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer if required.

- F. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.5 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
- E. Minimum R value for insulation: R=30 (verify before bid).

2.6 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, if required, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer. 24 fasteners per 4' x 8' board.
- C. Cover board Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive 4" o.c.
- D. Cover Board: ASTM C 1278, gypsum-fiber-reinforced, water-resistant gypsum substrate, 1/2 inch thick, adhere in 4" bead spacing.
 - 1. Acceptable Manufacturer: Securock by USG.
 - a. Product must be rated for a minimum 500 psi at roof assembly below the exterior roof terrace.

2.7 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer. Walkways to be installed on all 4 sides of all mechanical equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
 - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 - 2. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Div. 5 Section: "Steel Decking."
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 ROOFING INSTALLATION, GENERAL

- A. Adhere roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Membrane to run vertically up and over the parapet.

3.4 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
 - 1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
- G. Mechanically Fastened Insulation: Install all layers of insulation and secure to deck one time through all boards using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Pattern to be 12 fasteners per 4' x 8' board.
 - 2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof for 90 mph warranty requirements.
 - 3. Adhere the Securock cover board.

3.5 ADHERED ROOFING INSTALLATION

- A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.
- E. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.
- F. Apply roofing with side laps shingled with slope of roof deck where possible.
- G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of 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.
 - 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. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.6 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.7 WALKWAY INSTALLATION

- A. Flexible Walkways if shown: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.8 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
- B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

3.9 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 54 23

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manufactured reglets with counterflashing.
2. Formed roof-drainage sheet metal fabrications.
3. Formed low-slope roof sheet metal fabrications.
4. Formed steep-slope roof sheet metal fabrications.
5. Formed wall sheet metal fabrications.
6. Formed equipment support flashing.

B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 07 71 00 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.
3. Section 07 72 00 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.3 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each of the following
 - 1. Underlayment materials.
 - 2. Elastomeric sealant.
 - 3. Butyl sealant.
 - 4. Epoxy seam sealer.

- B. Shop Drawings: For sheet metal flashing and trim.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
 - 3. Include identification of material, thickness, weight, and finish for each item and location in Project.
 - 4. Include details for forming, including profiles, shapes, seams, and dimensions.
 - 5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - 6. Include details of termination points and assemblies.
 - 7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
 - 8. Include details of roof-penetration flashing.
 - 9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
 - 10. Include details of special conditions.
 - 11. Include details of connections to adjoining work.
 - 12. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches (1:10).

- C. Samples: For each exposed product and for each color and texture specified, 12 inches (300 mm) long by actual width.

- D. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

- E. Samples for Verification: For each type of exposed finish.
 - 1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches (300 mm) long and in required profile. Include fasteners and other exposed accessories.
 - 3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
 - 4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

- B. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
 - 1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
 - 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
 - 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in

construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- D. SPRI Wind Design Standard: Manufacture and install copings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
 - 1. Design Pressure: As indicated on Drawings.
- E. FM Approvals Listing if required by Owner: Manufacture and install copings and roof edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with name of fabricator and design approved by FM Approvals.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; Consider including ASTM A666 stainless steel in "Stainless Steel Sheet" Paragraph below if permitted by authorities having jurisdiction. The IBC requires ASTM A240/A240M, Series 300 alloys for stainless steel roof covering but does not state a specific alloy for flashing and trim. Last option may diminish oil-canning effect.
 - 1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Color: Match Valspar High Performance Architectural Coatings; Dove Gray 432R 1021 (Coil). (Verify color with Owner)
 - 3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
 - 1. Finish: No. 2D (dull, cold rolled).
 - a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1) Run grain of directional finishes with long dimension of each piece.
 - 2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils (0.76 mm) thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.
 - 1. Source Limitations: Obtain underlayment from single source from single manufacturer.
 - 2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F (29 deg C) or lower.
- B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- D. Elastomeric Sealant: ASTM C920, elastomeric sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

- E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- G. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

2.5 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
 - 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 - 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 - 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 - 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
 - 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
 - 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49, if required, for application, but not less than thickness of metal being secured.
- G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.

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

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters:

1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
2. Fabricate in minimum 96-inch- (2400-mm-) long sections.
3. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
4. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
5. Expansion Joints: Butt type with cover plate.
6. Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen. Valley baffles.
7. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:
 - a. Aluminum: 0.032 inch (0.81 mm) thick or Stainless Steel: 0.016 inch (0.40 mm) thick. Verify material.
8. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:
 - a. Aluminum: 0.040 inch (1.02 mm) thick. Verify material.
 - b. Stainless Steel: 0.019 inch (0.48 mm) thick. Verify material.

B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors

C. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper. Fabricate from the following materials:

1. Aluminum: 0.032 inch (0.81 mm) thick. Verify material.
2. Stainless Steel: 0.019 inch (0.48 mm) thick. Verify material.

D. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes, exterior flange trim, and built-in overflows. Fabricate from the following materials:

1. Aluminum: 0.032 inch (0.81 mm) thick. Verify material.
2. Stainless Steel: 0.016 inch (0.40 mm) thick. Verify material.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing (Gravel Stop) and Fascia Cap. Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long sections. Furnish with 6-inch- (150-mm-) wide, joint cover plates. Shop fabricate interior and exterior corners. Options in "Joint Style" Subparagraph below describe joint configurations detailed by NRCA and SMACNA. Revise to suit Project. Insert descriptions here or indicate special corner and edge styles on Drawings if required.
1. Joint Style: Butted with expansion space and 6-inch- (150-mm-) wide, exposed cover plate.
 2. Fabricate with scuppers spaced 10 feet (3 m) apart, to dimensions required with 4-inch- (100-mm-) wide flanges and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
 3. Fabricate from the following materials:
 - a. Aluminum: 0.050 inch (1.27 mm) thick. Verify material.
 - b. Stainless Steel: 0.019 inch (0.48 mm) thick. Verify material.
- B. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Aluminum: 0.040 inch (1.02 mm) thick. Verify material.
 2. Stainless Steel: 0.019 inch (0.48 mm) thick. Verify material.

2.8 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
1. Aluminum: 0.032 inch (0.81 mm) thick. Verify material.
 2. Stainless Steel: 0.016 inch (0.40 mm) thick. Verify material.
- B. Valley Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch (0.48 mm) thick.
- C. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Aluminum: 0.032 inch (0.81 mm) thick. Verify material.
 2. Stainless Steel: 0.019 inch (0.48 mm) thick. Verify material.

2.9 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings; and form with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
1. Stainless Steel: 0.016 inch (0.40 mm) thick.

2.10 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch (0.48 mm) thick.
- B. Overhead-Piping Safety Pans: Fabricate from the following materials:

1. Stainless Steel: 0.025 inch (0.64 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
 1. Verify compliance with requirements for installation tolerances of substrates.
 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.
 1. Install in shingle fashion to shed water.
 2. Lap joints not less than 2 inches (50 mm).
- B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
 1. Lap horizontal joints not less than 4 inches (100 mm).
 2. Lap end joints not less than 12 inches (300 mm).
- C. Self-Adhering, High-Temperature Sheet Underlayment:
 1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
 2. Prime substrate if recommended by underlayment manufacturer.
 3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses.
 5. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller.
 6. Roll laps and edges with roller.
 7. Cover underlayment within 14 days.
- D. Install slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.
 1. Install in shingle fashion to shed water.
 2. Lap joints not less than 4 inches (100 mm).

3.3 INSTALLATION, GENERAL

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
 4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
 5. Install continuous cleats with fasteners spaced not more than 12 inches (300 mm) o.c.
 6. Space individual cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
 8. Do not field cut sheet metal flashing and trim by torch.
 9. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
 2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
 3. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated.
 - a. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant.
 - b. Form joints to completely conceal sealant.

- c. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
 - 2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
- 1. Pre-tin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work.
 - 2. Do not solder aluminum sheet.
 - 3. Do not use torches for soldering.
 - 4. Heat surfaces to receive solder, and flow solder into joint.
 - a. Fill joint completely.
 - b. Completely remove flux and spatter from exposed surfaces.
 - 5. Stainless Steel Soldering:
 - a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
 - b. Promptly remove acid-flux residue from metal after tinning and soldering.
 - c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
- H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.4 INSTALLATION OF ROOF-DRAINAGE SYSTEM

- A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters:
- 1. Join sections with joints sealed with sealant.
 - 2. Provide for thermal expansion.
 - 3. Attach gutters at eave or fascia to firmly anchor them in position.
 - 4. Provide end closures and seal watertight with sealant.
 - 5. Slope to downspouts.
 - 6. Fasten gutter spacers to front and back of gutter.
 - 7. Anchor and loosely lock back edge of gutter to continuous cleat.
 - 8. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
- C. Downspouts:
- 1. Join sections with 1-1/2-inch (38-mm) telescoping joints.
 - 2. Provide hangers with fasteners designed to hold downspouts securely to walls.
 - 3. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c.
 - 4. Provide elbows at base of downspout to direct water away from building.
 - 5. Connect downspouts to underground drainage system.

- D. Splash Pans:
 - 1. Install where downspouts discharge on low-slope roofs.
- E. Parapet Scuppers:
 - 1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
- F. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch (25 mm) below scupper or gutter discharge.

3.5 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.
 - 1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
 - 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing:
 - 1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
 - 2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.
 - 3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.
- C. Copings:
 - 1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
 - 2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.
 - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch (400-mm) centers.
 - 3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
 - 1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
 - 2. Extend counterflashing 4 inches (100 mm) over base flashing.
 - 3. Lap counterflashing joints minimum of 4 inches (100 mm).

- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL FLASHINGS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

3.7 INSTALLATION OF MISCELLANEOUS FLASHING

- A. Equipment Support Flashing:
 - 1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
 - 2. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans:
 - 1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
 - 2. Pipe and install drain line to plumbing waste or drainage system.

3.8 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

3.10 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 07 62 00

SECTION 076526 - SELF-ADHERING SHEET FLASHING

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 self-adhering flashing and accessory products.
- B. Related Requirements:
 - 1. Section 04 20 00 - Unit Masonry: For flexible flashing associated with masonry.
 - 2. Section 07 27 26 – Fluid-Applied Membrane Air Barriers: For flashing installed as part of air barrier system.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including installation procedures.
- B. Shop Drawings: Show locations of flashing and details for all conditions.

1.4 INFORMATIONAL SUBMITTALS

- A. Certification of compatibility by Manufacturer, listing all materials on the Project with which the flashing and accessories may come into contact.
- B. Sample Warranty: For manufacturer's warranty.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product, lot number and directions for storage.
- B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by Manufacturer.
- C. Protect stored materials from direct sunlight.

1.6 FIELD CONDITIONS

- A. Do not apply during rain or accumulating snowfall.
- B. Apply Product and accessories within temperature range indicated in Manufacturer's literature.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace self-adhering sheet flashing that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-ADHERING SHEET FLASHING

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle Residential; a division of Carlisle Construction Materials.
 - b. Grace Construction Products; W.R. Grace & Co. -- Conn.
 - c. Henry Company.
 - d. Metal-Fab Manufacturing, LLC.
 - e. Owens Corning.
 - f. Polyguard Products, Inc.
 - g. Equal product approved by Architect in an addendum.
 - 2. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
 - 3. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).

2.2 ACCESSORIES

- A. VOC Content: 250 g/L or less.
- B. Primer: Product recommended by manufacturer of flexible flashing for substrate.
- C. Adhesive: Product recommended by manufacturer of flexible flashing for substrate.
- D. Mastic: Product recommended by manufacturer of flexible flashing for substrate.
- E. Fill Compound: Product recommended by manufacturer of flexible flashing for substrate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions affecting installation of the flashing and

accessory products for compliance with requirements. Verify that surfaces and conditions are suitable prior to commencing Work of this section.

- B. Prepare written report listing conditions detrimental to performance.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent surfaces not designated to receive self-adhering flashing membrane.
- B. Clean surfaces to receive membrane in accordance with manufacturer's instructions.
- C. Fill joints and cracks greater than ¼ inch width with fill compound struck flush.
- D. Fill inside corners and angle changes with minimum ½ inch tooled bead of fill compound.

3.3 INSTALLATION

- A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free to sound substrate.
 - 1. Prime substrate if recommended by underlayment manufacturer.
 - 2. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
 - 3. Precut pieces of flashing to easily handled lengths for each location.
 - 4. Apply adhesive as recommended by flashing manufacturer for substrate.
 - 5. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller.
 - 6. Apply mastics to edges at laps, cuts, and penetrations as recommended by flashing manufacturer.
 - 7. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.
 - 8. Cover underlayment within number of days indicated in Manufacturer's printed material.

3.4 REPAIR AND PROTECTION

- A. Protect from damage during application and remainder of construction period.
- B. Inspect before covering and make repairs according to Manufacturer's instructions. Remove and replace damaged material.

END OF SECTION 07 65 26

SECTION 07 71 00 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Copings.
2. Roof-edge specialties.
3. Reglets and counterflashings.

B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 07 62 00 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
3. Section 07 72 53 "Snow Guards" for manufactured snow guard devices.
4. Section 07 92 00 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

C. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties.

1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.

3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
 4. Detail termination points and assemblies, including fixed points.
 5. Include details of special conditions.
- C. Samples: For each type of roof specialty and for each color and texture specified.
- D. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.
- E. Samples for Verification:
1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
 2. Include copings made from 12-inch (300-mm) lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.
- 1.4 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of roof specialty.
- C. Product Test Reports: For copings, for tests performed by a qualified testing agency.
- D. Sample Warranty: For manufacturer's special warranty.
- 1.5 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For roofing specialties to include in maintenance manuals.
- 1.6 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class if required, verify with Owner.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and set quality standards for fabrication and installation.
1. Build mockup of typical roof edge as shown on Drawings.
 2. Build mockup of typical roof edge as part of Integrated Exterior Mockup specified in Section 01 40 00 "Quality Requirements"
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
- B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COPINGS

- A. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps. Coping to be approved for use as FM Class 1-120.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hickman Company, W. P; Permasnap or a comparable product by one of the following:
 - a. Metal-Era, Inc.
 - b. Petersen Aluminum Corporation.
 - 2. Coping-Cap Material: Formed aluminum, 0.080 inch (2.03 mm) thick.
 - a. Finish: Two-coat fluoropolymer.
 - b. Color: Match Valspar High Performance Architectural Coatings; Dove Gray 432R 1021 (Coil). (Verify color with Owner)

3. Corners: Factory mitered and continuously welded.
4. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.
5. Snap-on-Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.
6. Face Leg Cleats: Concealed, continuous galvanized-steel sheet.

2.2 ROOF-EDGE SPECIALTIES

- A. Canted Roof-Edge Fascia and Gravel Stop: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous formed galvanized-steel sheet cant, 0.028 inch (0.71 mm) thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hickman Company, W. P; Econosnap or a comparable product by one of the following:
 - a. Metal-Era, Inc.
 - b. Petersen Aluminum Corporation.
 2. Formed Aluminum Sheet Fascia Covers: Aluminum sheet, minimum 0.050 inch (1.27 mm) thick.
 - a. Surface: Smooth, flat finish.
 - b. Finish: Two-coat fluoropolymer.
 - c. Color: Match Valspar High Performance Architectural Coatings; Dove Gray 432R 1021 (Coil).
 3. Corners: Factory mitered and soldered.
 4. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.
 5. Fascia Accessories: Fascia extenders with continuous hold-down cleats.
- B. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding 12 feet (3.6 m), with a horizontal flange and vertical leg, drain-through fascia terminating in a drip edge, and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hickman Company, W. P; Drain Thru Gravel Stop or a comparable product by one of the following:
 - a. Architectural Products Company.
 - b. Metal-Fab Manufacturing, LLC.
 - c. Penn Sheet Metal.
 - d. Petersen Aluminum Corporation.
 2. Formed Aluminum Sheet Gravel Stops: Aluminum sheet, 0.050 inch (1.27 mm) thick.
 - a. Surface: Smooth, flat finish.
 - b. Finish: Two-coat fluoropolymer.
 - c. Color: Match Valspar High Performance Architectural Coatings; Dove Gray 432R 1021 (Coil).

2.3 REGLETS AND COUNTERFLASHINGS

- A. Reglets and Receivers: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
 - 1. Formed Aluminum: 0.050 inch (1.27 mm) thick.
 - 2. Corners: Factory mitered and continuously welded.
 - 3. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
- B. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into receiver and compress against base flashings with joints lapped, from the following exposed metal:
 - 1. Formed Aluminum: 0.032 inch (0.81 mm) thick.
- C. Aluminum Finish: Two-coat fluoropolymer.
 - 1. Color: Match Valspar High Performance Architectural Coatings; Dove Gray 432R 1021 (Coil).

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
1. Apply continuously under copings, roof-edge specialties, and reglets and counterflashings.
 2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.
- B. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
- C. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

3.3 INSTALLATION, GENERAL

- A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 4. Torch cutting of roof specialties is not permitted.
 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum and stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise indicated on Drawings.
 2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

- D. Fastener Sizes: Use fasteners of sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
- E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.4 COPING INSTALLATION

- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.5 ROOF-EDGE SPECIALITIES INSTALLATION

- A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.6 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

- A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches (305 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
 - 1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion-joint caps.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.
 - 1. Provide elbows at base of downspouts at grade to direct water away from building.
 - 2. Connect downspouts to underground drainage system indicated.

3.7 REGLET AND COUNTERFLASHING INSTALLATION

- A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.
- B. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.
- C. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.8 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 71 00

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Roof hatches.
- B. Related Requirements:
 - 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Div. 07 "Roofing" for installing roof hatch sheet metal flashing and trim integral with membrane roofing.

1.3 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
 - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.
 - 2. Method of attaching roof accessories to roof or building structure.
 - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
 - 4. Required clearances.
- B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.2 ROOF HATCHES

- A. Roof Hatches: Metal roof-hatch units with lids and insulated single-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Bilco; Type NB Roof Hatch or comparable product by one of the following:

- a. Babcock-Davis.
 - b. Dur-Red Products.
 - c. Equal product approved by Architect in an addendum.
2. Type and Size: Single-leaf lid, 30 by 54 inches (750 by 1370 mm).
- B. Loads: Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.
- C. Hatch Material: Aluminum sheet, 0.090 inch (2.28 mm) thick.
1. Finish: Mill.
- D. Curb Material: Aluminum; mill finish.
1. Fabricate curbs to minimum height of 12 inches (300 mm) unless otherwise indicated.
- E. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
 2. Height: 42 inches (1060 mm) above finished roof deck.
 3. Material: Stainless steel.
 4. Post: 1-5/8-inch- (41-mm-) diameter pipe.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
 - 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof-Hatch Installation:
 - 1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 - 2. Attach safety railing system to roof-hatch curb.
 - 3. Attach ladder-assist post according to manufacturer's written instructions.

3.3 REPAIR AND CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.
- B. Clean off excess sealants.
- C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 72 00

SECTION 07 72 53 - SNOW GUARDS

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. Pad-type, seam-mounted snow guards.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
 - 1. Include details of rail-type snow guards.
- C. Samples:
 - 1. Pad-Type Snow Guards: Full-size unit.
 - a. For units with factory-applied finishes, submit manufacturer's standard color selections.
- D. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Include calculation of number and location of snow guards.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.
- B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating point of failure of attachment to roof system identical as that used on this Project.

1.5 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design snow guards, including attachment to building, based on the following:
 - 1. Roof snow load.
 - 2. Snow drifting
 - 3. Roof slope.
 - 4. Roof type.
 - 5. Roof dimensions.
 - 6. Roofing substrate type and thickness.
 - 7. Snow guard type.
 - 8. Snow guard fastening method and strength.
 - 9. Snow guard spacing.
 - 10. Coefficient of Friction Between Snow and Roof Surface: 0.
 - 11. Factor of Safety: 2.
- B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
 - 1. Snow Loads: As indicated on Drawings.

2.2 PAD-TYPE SNOW GUARDS

- A. Flat-Mounted Metal Pad-Type Snow Guards:
 - 1. Material: ASTM B209 (ASTM B209M), 0.040-inch- (1.02-mm-) thick aluminum sheet.
 - a. Finish: High-performance organic two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.
 - 1) Color: Match sheet metal roofing.
 - 2. Attachment: Manufacturer's tested system, capable of resisting design loads.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.
 - 1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare substrates for bonding snow guards.
- B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

- A. Install snow guards according to manufacturer's written instructions.
 - 1. Space rows as indicated on Shop Drawings.
 - 2. Space rows as recommended by manufacturer.
- B. Attachment for Standing-Seam Metal Roofing:
 - 1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
 - 2. Seam-Mounted, Pad-Type Snow Guards:
 - a. Install snow guards in straight rows.
 - b. Secure in place using stainless-steel set screws, incorporating round nonpenetrating point.
 - c. Torque set screw according to manufacturer's instructions.

END OF SECTION 07 72 53

SECTION 07 84 33 - JOINT AND PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

1.2 DEFINITIONS

- A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.3 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

The subcontractors of this project are all to use products made by the same company. The GC (or CM) will tell them which company to use. All of the subcontractors on the project, including but not limited to the following subcontractors, are each responsible for firestopping their own installations:

- Gypsum Board Contractors.
- Masonry Contractors.
- Concrete Contractors.
- Carpentry Contractors.
- Section 21 00 00 - Fire Suppression
- Section 22 00 00 - Plumbing
- Section 23 00 00 - Heating, Ventilating, and Air Conditioning
- Section 26 00 00 - Electrical
- Section 27 00 00 – Communications

Work in this section includes, but is not limited to:

- A. Safing slot gaps between edge of floor slabs and perimeter curtain walls.
- B. Openings between structurally separate sections of wall or floors.
- C. Gaps between the top of walls and ceilings or roof assemblies.
- D. Expansion joints in walls and floors.
- E. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
- F. Blank openings through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
- G. Openings and penetrations in fire-rated partitions or walls containing fire doors.
- H. Openings around structural members which penetrate floors or walls.

1.4 RELATED WORK OF OTHER SECTIONS

- A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:

1. Section 03 30 00 - Cast-In-Place Concrete
2. Section 04 20 00 - Unit Masonry
3. Section 09 29 00 - Gypsum Board
4. Section 21 00 00 - Fire Suppression
5. Section 22 00 00 - Plumbing
6. Section 23 00 00 - Heating, Ventilating, and Air Conditioning
7. Section 26 00 00 - Electrical
8. Section 27 00 00 – Communications

1.5 REFERENCES

- A. Underwriters Laboratories, Inc. (UL) Fire Resistance Directory, Volume II, updated annually:
 1. Joint Systems (XHBN)
 2. Perimeter Fire Containment Systems (XH DG)
 3. Fire Resistance Ratings (BXRH)
 4. Fill, Voids, or Cavity Material (XHHW)
 5. Forming Materials (XHKU)
 6. Firestop Devices (XHJI)
 7. Through-Penetration Firestop Systems (XHEZ)
- B. Omega Point Laboratories, Inc. (OPL) Listed Products Directory, Volume II, updated annually:
 1. Fire Resistant Joint Systems
- C. ASTM E 1966, "Standard Test Method for Fire-Resistive Joint Systems"
- D. ASTM E 1399, "Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Width of Architectural Joint Systems"
- E. ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials"
- F. ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops"
- G. ASTM E 2307, "Standard Test Method for Determining the Fire Endurance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus"
- H. ANSI/UL 2079, "Tests for Fire Resistance of Building Joint Systems"
- I. ASTM D6904, "Standard Practice for Resistance to Wind-Driven Rain"
- J. International Firestop Council Recommended (IFC) Guidelines for Evaluating Firestop Systems Engineering Judgments
- K. International Building Code (IBC 2009)
- L. NFPA 101 - Life Safety Code
- M. ASTM C679, "Standard Test Method for Tack-Free Time of Elastomeric Sealants"
- N. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"
- O. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Firestops"
- P. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.

1. UL Fire Resistance Directory:
 - a. Firestop Devices (XHJI)
 - b. Fire Resistance Ratings (BXRH)
 - c. Through-Penetration Firestop Systems (XHEZ)
 - d. Fill, Voids, or Cavity Material (XHHW)
 - e. Forming Materials (XHKU)
- Q. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- R. All major building codes: ICBO, SBCCI, BOCA, IBC and Building Code of the City of New York.
- S. NFPA 70 - National Electric Code

1.6 QUALITY ASSURANCE

- A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- B. Fire-Test-Response Characteristics: Provide through-penetration fire stop systems that comply with specified requirements of tested systems.
- C. Firestop System installation shall meet requirements of ASTM E 814, ASTM E 1966 and/or ANSI/UL 2079 or UL 1479 tested and listed assemblies that provide fire-resistance ratings not less than that of the construction in which the joint occurs.
- D. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
- E. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.
- F. For those firestop applications that exist for which no tested and listed system is available through a manufacturer, an engineering judgment derived from similar tested system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment documents shall follow requirements set forth by the International Firestop Council.

1.7 SUBMITTALS

- A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of tested firestop systems to be used and manufacturer's installation instructions to comply with Division 01 Section "Submittals".
- B. Manufacturer's engineering judgment identification number and details when no tested and listed system is available for an application. Engineering judgment shall include both project name and contractor's name who will install firestop system as described in document.
- C. Submit safety data sheets provided with product delivered to job-site.

1.8 INSTALLER QUALIFICATIONS

- A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products

to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

- B. The work is to be installed by a contractor with at least one of the following qualifications:

FM 4991 Approved Contractor
UL Approved Contractor

- C. Installer shall have not less than 3 years experience with fire stop installation.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL or OPL label, where applicable.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions.
- D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- E. Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

- A. Do not use materials that contain flammable solvents.
- B. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.
- C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
- D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
- E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.
- F. Comply with ASTM D 6905 (modified) for resistance to wind driven rain and water.

PART 2 - PRODUCTS

2.1 JOINT FIRESTOPPING - GENERAL

- A. Provide firestopping composed of components that are compatible with each other and substrates forming joints under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- B. Provide components for each fire-resistive joint system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

- C. Joints in or between Fire Rated Construction: Provide joint firestopping systems with ratings determined per UL 2079 or ASTM E 1966:
1. F-Rating: not less than the fire resistance rating of the construction they will join.
- D. Joints at Exterior Curtain Wall / Floor Intersections: Provide joint firestopping systems with ratings determined per ASTM E 2307:
1. F-Rating: not less than the fire resistance rating of the construction they will join.
- E. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined per UL 2079:
1. L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.
- F. Joints at Intersection between Rated Wall Assemblies and Nonrated Horizontal Assemblies: Provide joint firestopping systems with ratings determined by ASTM E 2837.
- G. Mold Resistance: Provide joint firestopping system sealant with mold and mildew resistance rating of one (1) or less as determined by ASTM G21.
- H. Rain and water resistance: provide perimeter joint sealant tested in accordance with ASTM D 6904 with less than 1 hour tack free time as tested in accordance with ASTM C 679.
- I. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
- F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.
- J. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
- L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.
- K. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of zero (0) as determined by ASTM G21.

2.2 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with joint systems (XHBN) listed in Volume II of the UL Fire Resistance Directory or OPL Listed Products Directory; provide products by one of the following manufacturers as identified below; **Hilti Inc.** is the basis of design:
1. Grace Construction Products.
 2. Hilti Inc.
 3. Johns Manville.
 4. 3M Fire Protection Products.
 5. Tremco, Inc.; Tremco Fire Protection Systems Group.
 6. USG Corporation.

2.3 MATERIALS

- A. Use only firestop products that have been tested in accordance with UL 1479 or ASTM E 814 and ASTM E 1966 and/or ANSI/UL 2079 for specific rated construction conditions conforming to construction assembly type, movement capability, spacing requirements, and fire-resistance-rating involved for each separate instance.
- B. Sealants, sprays, or pre-formed materials for use with fire-rated construction joints and other gaps, the following products are acceptable:
1. Hilti Firestop Top Track Seal (CFS-TTS)
 2. Hilti Firestop Joint Spray (CFS-SP WB)
 3. Hilti Firestop Silicone Joint Spray (CFS-SP SIL)
 4. Hilti Flexible Firestop Sealant (CP 606)
 5. Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG)
 6. Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL)
 7. Hilti bottom of wall sealant CP 605
- C. Pre-installed firestop devices for use with noncombustible and combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors and/or gypsum walls, the following products are acceptable:
1. Hilti Cast-In Place Firestop Device (CP 680-P)
 - a. Add Aerator Adaptor when used in conjunction with aerator system.
 2. Hilti Tub Box Kit (CP 681) for use with tub installations.
 3. Hilti Cast-In Place Firestop Device (CP 680-M) for use with noncombustible penetrants.
 4. Hilti Firestop Speed Sleeve (CP 653) for use with cable penetrations.
 5. Hilti Firestop Drop-In Device (CFS-DID) for use with noncombustible and combustible penetrants.
 6. Hilti Firestop Block (CFS-BL)
- D. Sealants for use as part of a Perimeter Fire Barrier System between fire-resistance-rated floors and exterior wall assemblies, the following products are acceptable:
1. Hilti Firestop Joint Spray (CFS-SP WB)
 2. Hilti Firestop Silicone Joint Spray (CFS-SP SIL)
 3. Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG)
 4. Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL)
- E. Pre-formed mineral wool designed to fit flutes of metal profile deck and gap between top of wall and metal deck profile; use as a backer for spray material.
1. Hilti Speed Plugs (CP 777)
 2. Hilti Speed Strips (CP 767)
- C. Sealants, caulking materials, or foams for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
1. Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 2. Hilti Fire Foam (CP 620)
 3. Hilti Flexible Firestop Sealant (CP 606)
- D. Sealants or caulking materials for use with sheet metal ducts, the following products are acceptable:
1. Hilti Flexible Firestop Sealant (CP 606)
 2. Hilti Intumescent Firestop Sealant (FS-ONE MAX)

- E. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe, the following products are acceptable:
1. Hilti Intumescent Firestop Sealant (FS-ONE MAX)
- F. Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles, the following products are acceptable:
1. Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 2. Hilti Fire Foam (CP 620)
 3. Hilti Flexible Firestop Sealant (CP 606)
- G. Non-curing, re-penetrable, intumescent putty or foam materials for use with flexible cable or cable bundles, the following products are acceptable:
1. Hilti Firestop Putty Stick (CP 618)
 2. Hilti Firestop Plug (CFS-PL)
- H. Wall opening protective materials for use with U.L. listed metallic and specified nonmetallic outlet boxes, the following products are acceptable:
1. Hilti Firestop Putty Pad (CP 617)
 2. Hilti Firestop Box Insert
- I. Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems), the following products are acceptable:
1. Hilti Firestop Collar (CP 643N)
 2. Hilti Firestop Collar (CP 644)
 3. Hilti Wrap Strips (CP 648E/648S)
- J. Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
1. Hilti Firestop Mortar (CP 637)
 2. Hilti Firestop Block (CFS-BL)
 3. Hilti Fire Foam (CP 620)
 4. Hilti Firestop Board (CP 675T)
- K. Non curing, re-penetrable materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
1. Hilti Firestop Block (CFS-BL)
 2. Hilti Firestop Board (CP 675T)
- L. For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:
1. Hilti Firestop Block (CFS-BL)
 2. Hilti Firestop Plug (CFS-PL)
- M. For single or cable bundles up to one inch diameter penetrating gypsum, masonry, concrete walls or wood floor assemblies the following product is acceptable:
1. Hilti CFS-D Firestop Cable Disc

- F. Provide a firestop system with an Assembly Rating as determined by ASTM E 1966 and/or ANSI/UL 2079 which is equal to the fire-resistance ratings of the construction in which the joint occurs.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 - 1. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
 - 2. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
 - 3. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
 - 4. Do not proceed until unsatisfactory conditions have been corrected.
 - 5. Verify penetrations are properly sized and in suitable condition for application of materials.

3.2 COORDINATION

- A. Coordinate construction of openings, penetrations and construction joints to ensure that the fire stop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems. Coordinate construction and sizing of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- C. Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.
- D. Do not cover up through-penetration fire stop and joint system installations that will become concealed behind other construction until each installation has been examined by the building inspector, per requirements of Section 109, International Building Code 2000, ed.

3.3 INSTALLATION

- A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory or Omega Point Laboratories Listed Products Directory.
- B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of construction joint materials.
 - 1. Protect materials from damage on surfaces subjected to traffic.
 - 2. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
 - 3. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.

3.4 FIELD QUALITY CONTROL

- A. Examine sealed joints to ensure proper installation before concealing or enclosing areas.
- B. Keep areas of work accessible until inspection by applicable code authorities and/or independent inspection agency.

- D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.
- E. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.
- F. Manufacturer's Field Services: During Installation, provide periodic destructive testing inspections to assure proper installation/application. After installation is complete, submit findings in writing indicating whether or not the installation of the tested system identified was installed correctly.

3.5 IDENTIFICATION & DOCUMENTATION

- A. The firestop contractor is to supply documentation for each single application addressed. This documentation is to identify each penetration and joint location on the entire project.
 - A.1 The Documentation Form for Construction Joints is to include:
 - 1. A Sequential Location Number
 - 2. The Project Name
 - 3. Date of Installation
 - 4. Detailed description of the Construction Joints location
 - 5. Tested System or Engineered Judgment Number
 - 6. Type of Construction Joint
 - 7. The Width of the Joint
 - 8. The Lineal Footage of the Joint
 - 9. Number of sides addressed
 - 10. Hourly rating to be achieved
 - 11. Installers Name
 - B. Copies of these documents are to be provided to the CONSTRUCTION MANAGER at the completion of the project.

3.6 ADJUSTING AND CLEANING

- A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.
- B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

3.7 LABOR USE TO INSTALL FIRESTOP SYSTEMS

- A. To ensure complete harmony on the project site, the installation of each scope of work is to be performed jurisdictionally correct per existing trade agreements.

3.8 SCHEDULE OF JOINT FIRESTOP SYSTEMS

Basis of design: Hilti, Inc.

Joint Type	F-Rating (Hr)	Hilti Basis of Design UL System	
		Joint Width Less than or Equal to 2"	Joint Width Greater than 2" Less than or Equal to 6" ⁴
Concrete (Floor to Floor)	1	FF-D-1012, FF-D-1013 ¹	FF-D-1012, FF-D-1013
	2	FF-D-1012, FF-D-1013 ¹	FF-D-1012, FF-D-1013
	3	FF-D-1011, FF-D-1026 ¹	FF-D-1011, FF-D-1026
	4	FF-D-1047	FF-D-1125
Concrete (Edge of Floor Slab to Wall)	1	FW-D-1011, FW-D-1012, FW-D-1013	FW-D-1011, FW-D-1012, FW-D-1013, FW-D-1021
	2	FW-D-1011, FW-D-1012, FW-D-1013	FW-D-1011, FW-D-1012, FW-D-1013, FW-D-1021
	3	FW-D-1011	FW-D-1011, FW-D-1021
	4	FW-D-1047	FW-D-1092
Concrete or Block Wall to Flat	1	N/A**	N/A**

Concrete Floor (Top-of-Wall)	2	HW-D-0097 ¹	HW-D-1009
	3	HW-D-1008 ¹ , HW-D 0268	HW-D-1008
	4	HW-D-1042	HW-D-1103
Concrete or Block Wall to Concrete Over Fluted Metal Deck (Top-of-Wall)	1	HW-D-0098	N/A**
	2	HW-D-0080, HW-D-0081, HW-D-0098	HW-D-1037
	3	N/A**	N/A**
Gypsum Wall to Flat Concrete Floor (Top-of-Wall)	4	HW-D-0294	N/A**
	1	HW-D-0757, HW-D-0082, HW-D-0083, HW-D-0106, HW-D-0119	HW-D-1011, HW-D-1012, HW-1020
	2	HW-D-0757, HW-D-0082, HW-D-0083, HW-D-0106, HW-D-0119	HW-D-1011, HW-D-1012, HW-1020
Gypsum Shaft Wall to (Top-of-Wall)	3	HW-D-0119	HW-D-1011, HW-D-1012, HW-1020
	2	HW-D-0342 (FLAT CONCRETE) HW-D-0541, HW-D-0542 (CONCRETE OVER METAL DECK)	N/A**
	1	BW-S-0023	N/A**
Gypsum Shaft Wall to Concrete Floor (Bottom-of-Wall)	2	BW-S-0023	N/A**
	1	BW-S-0001, BW-S-0002, BW-S-0039	N/A**
Gypsum Wall to Concrete Floor (Bottom-of-Wall)	2	BW-S-0001, BW-S-0002, BW-S-0039	N/A**
	1	HW-D-0042*, HW-D-0049*, HW-D-0087*, HW-D-0089*, HW-D-0045, HW-D-0046*, HW-D-0076*, HW-D-0077*, HW-D-0154, HW-D-0184*, HW-D-0292, HW-D-0295, HW-D-538*	HWD-1011, HWD-1012, HW-1020
Gypsum Wall to Concrete Over Fluted Metal Deck (Top-of-Wall)	2	HW-D-0042*, HW-D-0049*, HW-D-0087*, HW-D-0089*, HW-D-0045, HW-D-0046*, HW-D-0076*, HW-D-0077*, HW-D-0154, HW-D-0184*, HW-D-292, HW-D-0295, HW-D0538*	HW-D-1011, HW-D-1012, HW-D-1020
	3	HW-D-0292, HW-D-0295	HWD-1011, HWD-1012, HW-1020
	4	HW-D-0292, HW-D-0295	N/A**
	2	WW-D-0017, WW-D-0082	WW-D-1080, WW-D-1084
Concrete (Wall to Wall)	3	WW-D-1011 ¹ , WW-D-0032	WW-D-1011
	4	WW-D-1047	WW-D-1128
	1	WW-D-0040	N/A**
Gypsum to Concrete (Wall to Wall)	2	WW-D-0040	N/A**

* SEE NOTE 3 ** CONTACT HILTI FOR CURRENT UL-CLASSIFIED SYSTEM OR ENGINEER JUDGMENT DRAWING: 800-879-8000

NOTES:

1. CLASSIFIED SYSTEMS FOR 2" - 6" WIDE JOINTS MAY BE USED FOR JOINTS 2" WIDE AND LESS.
2. CONFIRM THAT MOVEMENT CAPABILITIES OF THE SELECTED UL SYSTEM MEETS OR EXCEEDS THE SPECIFIED MOVEMENT RANGE OF THE PARTICULAR JOINT.
3. SYSTEMS MARKED WITH ASTERIK (*) ARE SUITABLE FOR TOP-OF-WALL JOINTS WHERE THE FLUTED METAL DECK HAS SPRAY-ON MONOKOTE MK-6/HY FIREPROOFING.
4. VERIFY ALLOWABLE JOINT WIDTH ON SPECIFIC UL SYSTEM DRAWING.

3.9 SCHEDULE OF THROUGH PENETRATION FIRESTOP SYSTEMS

CONCRETE FLOORS			CONCRETE OR BLOCK WALLS		
TYPE OF PENETRANT	F-RATING (HR)	BASIS OF DESIGN UL SYSTEM	TYPE OF PENETRANT	F-RATING (HR)	BASIS OF DESIGN UL SYSTEM
CIRCULAR BLANK OPENINGS	1	F-A-0006, C-AJ-0055, C-AJ-0090	CIRCULAR BLANK OPENINGS	1	C-AJ-0055, C-AJ-0090
	2	F-A-0006, C-AJ-0055, C-AJ-0090		2	C-AJ-0055, C-AJ-0090
	3	F-A-0006, C-AJ-0055, C-AJ-0086,		3	C-AJ-0055, C-AJ-0086
SINGLE METAL PIPES OR CONDUIT	1	C-AJ-1226, F-A-1028, F-A-1017	SINGLE METAL PIPES OR CONDUIT	1	C-AJ-1226, W-J-1067, W-J-1020
	2	C-AJ-1226, F-A-1028, F-A-1017		2	C-AJ-1226, W-J-1067, W-J-1020, W-J-1248
	3	C-AJ-1226, F-A-1017		3	C-AJ-1226, W-J-1041, W-J-1068
	4	C-BJ -1037, C-BJ-1034		4	C-BJ-1034, C-BJ-1037, W-J-1041, W-J-1042, W-J-1068
SINGLE NON-METALLIC PIPE OR CONDUIT (I.E.	1	F-A-2053, F-A-2025, C-AJ-2109, C-AJ-2098, C-AJ-2271, C-AJ-2167,	SINGLE NON-METALLIC PIPE OR CONDUIT (I.E.	1	C-AJ-2109, C-AJ-2098, C-AJ-2167, C-AJ-2371, C-AJ-2342

PVC, CPVC, ABS, FRP, ENT)	2	C-AJ-2098, C-AJ-2271, C-AJ-2167, C-BJ-2021, C-AJ-2371, C-AJ-2342	PVC, CPVC, ABS, FRP, ENT)	2	C-AJ-2109, C-AJ-2098, C-AJ-2167, C-AJ-2371, C-AJ-2342	
	3	F-A-2054, C-AJ-2109, C-AJ-2098, C-AJ-2371, C-AJ-2342		3	C-AJ-2109, C-AJ-2098, C-AJ-2371, C-AJ-2342	
	4	C-BJ 2016, C-AJ-2017		4	W-J-2057, W-J-2091	
SINGLE/CABLE BUNDLES	1	F-A-3007,C-AJ-3095,C-AJ-3180, C-AJ-3283	SINGLE/CABLE BUNDLES	1	W-J-3036, C-AJ-3095, C-AJ-3180, W-J-3060, W-J-3167	
	2	F-A-3007,C-AJ-3095,C-AJ-3334, F-A-3060		2	W-J-3036, C-AJ-3095, C-AJ-3180, W-J-3060, W-J-3167, W-J-3189	
	3	F-A-3007, C-AJ 3095, C-AJ-3285		3	C-AJ-3095, C-AJ-3180, W-J-3167	
CABLE TRAY	1	C-AJ-4034, C-AJ-4035	CABLE TRAY	1	W-J-4027, C-AJ-4034, C-AJ-4035	
	2	C-AJ-4034, C-AJ-4035		2	W-J-4027, C-AJ-4034, C-AJ-4035	
	3	C-AJ-4034, C-AJ-4035		3	C-AJ-4034, C-AJ-4035	
SINGLE INSULATED PIPES	1	F-A 5015, F-A 5017, C-AJ-5090, C-AJ-5091, C-AJ-5090, C-AJ-5048	SINGLE INSULATED PIPES	1	C-AJ-5090, C-AJ-5091, C-AJ 5061, W-J-5042	
	2	F-A 5015, F-A 5017, C-AJ-5090, C-AJ-5091, C-AJ-5090		2	C-AJ-5090, C-AJ-5091, C-AJ-5061, W-J-5042	
	3	F-A 5016, C-AJ-5090, F-A-5018		3	C-AJ-5090, C-AJ-5061	
ELECTRICAL BUSWAY	1	C-AJ-6006, C-AJ-6017, F-A-6002, C-AJ-6036	ELECTRICAL BUSWAY	1	C-AJ-6006, C-AJ-6017, C-AJ-6036	
	2	C-AJ-6006, C-AJ-6017, F-A 6042, C-AJ-6036		2	C-AJ-6006, C-AJ-6017, C-AJ-6036	
	3	C-AJ-6006, C-AJ-6017		3	C-AJ-6006, C-AJ-6017	
MECHANICAL DUCTWORK WITHOUT DAMPERS NON-INSULATED	1	C-AJ-7046, C-AJ-7051, C-AJ-7084	MECHANICAL DUCTWORK WITHOUT DAMPERS NON-INSULATED	1	C-AJ-7046, C-AJ-7051, W-J-7021, W-J-7022	
	2	C-AJ-7046, C-AJ-7051, C-AJ-7085		2	C-AJ-7046, C-AJ-7051, W-J-7021, W-J-7022	
	3	C-AJ-7046, C-AJ-7051		3	C-AJ-7046, C-AJ-7051	
MECHANICAL DUCTWORK WITHOUT DAMPERS INSULATED	N/A**	N/A**	MECHANICAL DUCTWORK WITHOUT DAMPERS INSULATED	1	W-J-7029, W-J-7124	
MIXED PENETRANTS	1	C-AJ 8099, C-AJ-8056, C-AJ-8143	MIXED PENETRANTS	1	C-AJ 8099, C-AJ 8056, W-J 8007, C-AJ 8143	
	2	C-AJ-8099, C-AJ-8056, C-AJ-8143		2	C-AJ 8099, C-AJ 8056, W-J 8007, C-AJ 8143	
	3	C-AJ-8099, C-AJ-8056		3	C-AJ 8041, C-AJ 8056, W-J 8007, C-AJ 8099	
	4	C-AJ-8095		4	C-AJ 8095, W-J 8007	
WOOD FLOORS			GYPSON WALLS			
TYPE OF PENETRANT	F-RATING (HR)	BASIS OF DESIGN UL SYSTEM	TYPE OF PENETRANT	F-RATING (HR)	BASIS OF DESIGN UL SYSTEM	
METAL PIPES OR CONDUIT	1	F-C-1009, F-C-1059, F-C-1168	METAL PIPES OR CONDUIT	1	W-L-1054, W-L-1058, W-L-1164, W-L-1506	
	2	F-C-1009, F-C-1059, F-C-1168		2	W-L-1054, W-L-1058, W-L-1164, W-L-1506	
NON-METALLIC PIPE OR CONDUIT	1	F-C-2232, F-C-2030, F-C-2160, F-C-2389		NON-METALLIC PIPE OR CONDUIT	4	W-L-1110, W-L-1111, W-L-1165
	2	F-C-2029, F-C-2030, F-C-2128, F-C-2160	1		W-L-2078, W-L-2075, W-L-2128	
SINGLE OR BUNDLED CABLES	1	F-C-3012, F-C-3110, F-C-3044	SINGLE OR BUNDLED CABLES		2	W-L-2078, W-L-2075, W-L-2128
	2	F-C-3012, F-C-3110		4	W-L-2184, W-L-2245	
INSULATED PIPES	1	F-C-5004, F-C-5037, F-C-5036		CABLE TRAY	1	W-L-3065, W-L-3111, W-L-3112, W-L-3334, W-L-3414, W-L-3396
					2	W-L-3065, W-L-3111, W-L-3112, W-L-3334, W-L-3414, W-L-3396
	2	F-C-5004, F-C-5037	INSULATED PIPES	3	W-L-3385, W-L-3277	
				4	W-L-3139, W-L-3334	
NON-INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS	1	F-C-7013	NON-INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS	1	W-L-4011, W-L-4019, W-L-4081	
				2	W-L-4011, W-L-4019, W-L-4081	
				4	W-L 8014	
				1	W-L-5028, W-L-5029, W-L-5047	
INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS	1	N/A**	INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS	2	W-L-5028, W-L-5029, W-L-5047	
				2	W-L-5028, W-L-5029, W-L-5047	
MIXED PENETRANTS	1	F-C-8009, F-C-8014, F-C-8026	MIXED PENETRANTS	4	W-L 5073	
				1	W-L 7017, W-L-7040, W-L-7042, W-L-7155	
				2	W-L-7040, W-L-7042, W-L-7155	
MIXED PENETRANTS	1	F-C-8009, F-C-8014, F-C-8026	MIXED PENETRANTS	1	W-L-7059, W-L-7153, W-L-7156, W-L-7151	
				2	W-L-7059, W-L-7153, W-L-7156, W-L-7151	
				4	W-L-1095, W-L-8013	
MIXED PENETRANTS	1	F-C-8009, F-C-8014, F-C-8026	MIXED PENETRANTS	2	W-L-1095, W-L-8013	
				2	W-L-1095, W-L-8013	
				4	W-L-8014	

END OF SECTION 07 84 43

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Acoustical joint sealants.

- B. Related Sections:

1. Section 06 20 23 "Interior Architectural Woodwork" for sealing around window sills.
2. Section 07 84 46 "Fire-Resistive Joint Systems" for sealing joints in fire-resistance-rated construction.
3. Section 08 80 00 "Glazing" for glazing sealants.
4. Section 09 29 00 "Gypsum Board" for sealing perimeter joints.
5. Section 09 30 13 "Tiling" for sealing tile joints.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.

- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

- C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

- D. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- E. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
 - 1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
 - 2. Conduct field tests for each kind of sealant and joint substrate.
 - 3. Notify Architect seven days in advance of dates and times when test joints will be erected.
 - 4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - 5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
 - 6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.6 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 (5 deg C).
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer'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 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

- B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- E. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Omniseal 50.
 - b. Dow Corning Corporation; 756 SMS.
 - c. GE Advanced Materials - Silicones; SilGlaze II SCS2800.
 - d. Sika Corporation, Construction Products Division; SikaSil-C995.
 - e. Tremco Incorporated; Spectrem 3.
- B. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Omniplus.
 - b. Dow Corning Corporation; 786 Mildew Resistant.
 - c. GE Advanced Materials - Silicones; Sanitary SCS1700.
 - d. May National Associates, Inc.; Bondaflex Sil 100 WF.
 - e. Tremco Incorporated; Tremsil 200 Sanitary.

2.3 URETHANE JOINT SEALANTS

- A. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolastic SL 1.
 - b. Pecora Corporation; Urexpan NR-201.
 - c. Sika Corporation. Construction Products Division; Sikaflex - 1CSL.
 - d. Tremco Incorporated; Vulkem 45.
 - e. Tremco Incorporated; Tremflex S/L.
- B. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolastic NP 2.
 - b. Pecora Corporation; Dynatred.
 - c. Sika Corporation, Construction Products Division; Sikaflex - 2cNS.
 - d. Tremco Incorporated; Vulkem 227.
- C. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolastic NP 2.
 - b. Pecora Corporation; Dynatred.
 - c. Sika Corporation, Construction Products Division; Sikaflex - 2cNS.
 - d. Tremco Incorporated; Vulkem 227.

2.4 LATEX JOINT SEALANTS

- A. Latex Joint Sealant: 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. Pecora Corporation; AC-20+.
 - c. Tremco Incorporated; Tremflex 834.

2.5 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; AC-20 FTR.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.
 - c. Tremco, Acoustical Sealant 30CTG.

2.6 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; 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), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 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: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. 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.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. 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.
 - 4. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

- G. 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.
- H. Provide security joint sealants and security gap filler work as required under the General, Mechanical, and Electrical Sections.

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.

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontrafficsurfaces.
 - 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Joints between different exterior materials.
 - c. Joints in exterior insulation and finish systems.
 - d. Perimeter joints between materials listed above and frames of doors and windows.
 - e. Control and expansion joints in overhead surfaces.
 - f. Other joints as indicated.
 - 2. Silicone Joint Sealant: Single-component, nonsag, neutral-curing, Class 50.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in flooring.
 - c. Other joints as indicated.

2. Urethane Joint Sealant: Single-Component or Multicomponent, nonsag, traffic grade, Class 25.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings.
 - c. Masonry control and expansion joints.
 - d. Vertical joints on exposed surfaces of interior unit masonry partitions.
 - e. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
 - f. Other joints as indicated.
 2. Joint Sealant: Latex.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Sealant Location:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints.
 - c. Other joints as indicated.
 2. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Location:
 - a. Acoustical joints where indicated.
 - b. Other joints as indicated.
 2. Joint Sealant: Acoustical.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Interior standard steel doors and frames.
 - 2. Exterior standard steel doors and frames.
- B. Related Requirements:
 - 1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.
- B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Shop Drawings: Include the following:
1. Elevations of each door type.
 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of each different wall opening condition.
 6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 7. Details of anchorages, joints, field splices, and connections.
 8. Details of accessories.
 9. Details of moldings, removable stops, and glazing.
- D. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.
- E. Samples for Verification:
1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).
 2. Fabrication: Prepare Samples approximately 2 by 12 inches (305 by 305 mm) to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.
- F. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For door inspector.
1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
 2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
 3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.
- B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.
- C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.
- D. Field quality control reports.

1.8 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.9 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

- 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

- B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

- 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

- 1. Provide additional protection to prevent damage to factory-finished units.

- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Ceco Door; Assa Abloy.
 - 2. Kewanee Corporation (The).
 - 3. Pioneer Industries.
 - 4. Steelcraft; an Ingersoll-Rand brand.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
 - 2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 3. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
- B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.
- C. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.
 - 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches (44.5 mm).
 - c. Face: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
 - d. Edge Construction: Model 1, Full Flush.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges].
 - f. Core: Manufacturer's standard.
 - g. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated and temperature-rise-rated doors.
 - 2. Frames:
 - a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
 - b. Construction: Knocked down.
 - 3. Exposed Finish: Prime.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A.
 - 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches (44.5 mm).
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum A60 (ZF180) coating.
 - d. Edge Construction: Model 1, Full Flush.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges].
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Manufacturer's standard.
 - i. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation core for fire-rated doors.
 - 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum A60 (ZF180)] coating.
 - b. Construction: Full profile welded.
 - 3. Exposed Finish: Prime.

2.5 BORROWED LITES

- A. Fabricate of uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
- B. Construction: Knocked down.
- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 HOLLOW-METAL PANELS

- A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.7 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
 - 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.8 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.9 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
- D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
 4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.10 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.11 LOUVERS

- A. Provide louvers for interior doors, where indicated, which comply with SDI 111, with blades or baffles formed of 0.020-inch- (0.5-mm-) thick, cold-rolled steel sheet set into 0.032-inch- (0.8-mm-) thick steel frame.

1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
 2. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other.
 3. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same qualified testing and inspecting agency that established fire-resistance rating of door assembly.
- B. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. 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.
 - b. Install frames with removable stops located on secure side of opening.
 2. Fire-Rated Openings: Install frames according to NFPA 80.
 3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 4. Solidly pack mineral-fiber insulation inside frames.
 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

- a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
1. Non-Fire-Rated Steel Doors: Comply with NAAMM-HMMA 841 and NAAMM-HMMA guide specification indicated.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 3. Smoke-Control Doors: Install doors according to NFPA 105.
- D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
1. Fire-Rated Door Inspections: Inspect each fire-rated door according to NFPA 80, Section 5.2.
 2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

SECTION 08 11 16 - ALUMINUM DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes exterior flush aluminum doors and frames.
- B. Related Requirements:
 - 1. Section 08 41 13 "Aluminum-Framed Entrances and Storefronts" for storefront framing and coordinating finish among aluminum fenestration units.
 - 2. Section 08 71 00 "Door Hardware" for door hardware.

1.2 ACTION SUBMITTALS

- A. Product Data: Manufacturer's descriptive literature for each type door and frame. Include the following information:
 - 1. Fabrication methods.
 - 2. Finishing.
 - 3. Hardware preparation.
 - 4. Accessories.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Shop Drawings: Indicate the following:
 - 1. Elevations and details of each door and frame type.
 - 2. Schedule of doors and frames.
 - 3. Conditions at openings with various wall thicknesses and materials. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 - 4. Location and installation requirements for hardware.
 - 5. Thicknesses of materials, joints.
 - 6. Connections and trim.
- D. Verification Samples:
 - 1. Submit samples of each type, consisting of aluminum door corner construction, minimum 6-inch by 6-inch (150 mm) legs.

- E. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- F. Hardware Templates: Provide finish hardware mounting details.
- G. Manufacturer's Installation Instructions: Printed installation instructions for each product, including product storage requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum doors and frames to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing aluminum door and frame systems of the type required for this project, with minimum ten continuous years documented experience.
- B. Product Qualifications: Wind-load test certification conforming to ASTM E 330 on samples of previous products shall be provided for the type of door to be used.
- C. Installer's Qualifications: Workmen skilled in handling aluminum door and frame systems of the type required for this project.
- D. Instruction: The manufacturer or his representative will be available for consultation to all parties engaged in the project, including instruction to installation personnel.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames palletted, or individually crated. Doors shall be side protected with surrounding grooved 2-inch (50.8 mm) by 4-inch (101.6 mm) wood frame and covered with 275-pound (124.74 kg) test corrugated cardboard.
- B. Inspect delivered doors and frames for damage; unload and store with minimum handling. Repair minor damage if refinished items are equal in all respects to new work; otherwise, remove damaged items and replace with new.
- C. Store products of this section under cover in manufacturer's unopened packaging until installation.
 - 1. Place units on minimum 4-inch (101.6 mm) wood blocking.
 - 2. Avoid non-vented plastic or canvas covers.
 - 3. Remove packaging immediately if packaging becomes wet.
 - 4. Provide 0.25-inch (6.35 mm) air spaces between stacked doors.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of aluminum doors and frames that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Ten year(s) from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - 2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS – HEAVY DUTY ALUMINUM EXTERIOR DOORS AND FRAMES

- 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. Cline Aluminum Doors, Inc.
 - 2. Cross Aluminum Products, Inc.
 - 3. Special Lite, Inc.
 - 4. Kawneer North America; an Alcoa company.

2.2 MATERIALS

- A. Aluminum Members: Alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish.

2.3 FRAMING

- A. Framing Members: Manufacturer's heavy duty extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Construction: Thermally broken.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
 - 1. Aluminum: Heavy Duty Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.

2.4 ALUMINUM DOOR

- A. Flush Heavy Duty Aluminum Door Composite Components: Minimum 5-ply composite laminated construction to include:
 - 1. Facing: One-piece 0.040-inch (1.02 mm) smooth 5005-H14 stretcher-leveled aluminum alloy.
 - 2. Substrate: One-piece 0.085-inch (2.16 mm) oil-tempered hardboard; neither pegboard nor non-tempered hardboard shall be accepted.
 - 3. Core: Pre-stabilized, five pound minimum, EPS foam. No injected foams or poured-in-place foams acceptable to avoid air pockets and destabilization.
 - 4. Hardware Backup: Provide continuous, nonspecific hardware reinforcement with full internal perimeter aluminum tube, 4.25-inches (108 mm) in width, 0.125-inch (3.18 mm) minimum wall thickness.
 - 5. Bonding Agent: Shall be a commercial bonding adhesive with a strength buildup of 350 pounds per square inch (24.6 kg/cm²).
 - 6. Extrusion Wall: Thickness of 0.125-inch (3.18 mm) minimum, except beads and trim.
 - 7. Beads and Trim: Wall Thickness of 0.050-inch (1.25 mm) minimum. Replaceable lock stile door edge of 6063-T5 extruded aluminum alloy with special beveled edge cap design shall be provided with integral weatherstripping. Hinge lock style to a clip mortise square edge design to accommodate standard weight and heavy weight butt hinges. Use of integral door edging not acceptable.
 - 8. Weatherstripping: Replaceable wool pile with nylon fabric, polypropylene backing meeting AAMA 701 standards.

2.5 FINISH

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker, unless otherwise shown.

2.6 FABRICATION

- A. General: Receive hardware if required by manufacturer.
- B. Aluminum Flush Door Construction: Of type, size and design indicated:
 - 1. Minimum Thickness: 1.75-inches (44 mm), 5-ply composite laminate system. No 3-ply doors accepted for commercial application.
 - 2. Door Size: Sizes shown are nominal; provide standard clearances as follows:
 - a. Hinge and Lock Stiles: 0.125-inch (3.18 mm).
 - b. Between Meeting Stiles: 0.25-inch (6.35 mm).
 - c. At Top Rails: 0.125-inch (3.18 mm).
 - d. Between Door Bottom and Threshold: 0.125-inch (3.18 mm).
 - 3. Face Panels: Exterior and interior aluminum panels shall be one-piece stretcher-leveled aluminum alloy, each laminated edge-to-edge to one-piece oil-tempered hardboard substrate.
 - 4. Substrate: Oil-tempered hardboard substrates shall have 100-percent bilateral lamination to a pre-stabilized, five pound minimum, EPS foam core and internal hardware backup tube.
 - 5. Reinforcement: Internal tube shall reinforce the full internal door perimeter to allow for all specified and non-specified hardware.
 - 6. Core: Pre-stabilized, five pound minimum, EPS foam core shall have 100-percent bilateral lamination to facing substrate and to internal reinforcement system.
 - 7. Door Edge: Door perimeter shall be trimmed with a field replaceable 6063-T5 extruded aluminum alloy, with a beveled edge on the lock stile and a clip mortise squares edged on the hinge stile, to protect door edges.
 - 8. Weatherstripping: Lock stile of door shall have wool pile weatherstripping applied.

2.7 ACCESSORIES

- A. Fasteners: Aluminum, non-magnetic stainless steel, or other material warranted by manufacturer as non-corrosive and compatible with aluminum components.
 - 1. Do not use exposed fasteners.
- B. Brackets and Reinforcements: Manufacturer's high-strength aluminum units where feasible, otherwise, nonferrous stainless steel.
- C. Bituminous Coating: Cold-applied asphaltic mastic, compounded for 30-mil (0.76 mm) thickness per coat.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that wall surfaces and openings are ready to receive frames and are within tolerances specified in manufacturer's instructions.

3.2 PREPARATION

- A. Perform cutting, fitting, forming, drilling, and grinding of frames as required for project conditions; do not damage sight-exposed finishes.
- B. Separate dissimilar metals to prevent electrolytic action between metals.

3.3 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and approved shop drawings; set frames plumb, square, level, and aligned to receive doors.
- B. Anchor frames to adjacent construction in strict accordance with recommendations and approved shop drawings and within tolerances specified in manufacturer's instructions.
 - 1. Seal metal-to-metal joints between framing members using good quality elastomeric sealant.
- C. Where aluminum surfaces contact with metals other than stainless steel, zinc or small areas of white bronze, protect from direct contact by one or more of the following methods.
 - 1. Paint dissimilar metal with one coat of heavy-bodied bituminous paint.
 - 2. Apply good quality elastomeric sealant between aluminum and dissimilar metal.
 - 3. Paint dissimilar metal with one coat of primer and one coat of paint recommended for aluminum surface applications.
 - 4. Use non-absorptive tape or gasket in permanently dry locations.
- D. Hang doors with required clearances as follows:
 - 1. Hinge and Lock Stiles: 0.125-inch (3.18 mm).
 - 2. Between Meeting Stiles: 0.250-inch (6.35 m).
 - 3. At Top Rails: 0.125-inch (3.18 mm).
 - 4. Between Door Bottom and Threshold: 0.125-inch (3.18 mm).
- E. Adjust doors and hardware to operate properly.

3.4 CLEANING

- A. Upon completion of installation, thoroughly clean door and frame surfaces in accordance with AAMA 609.
- B. Do not use abrasive, caustic or acid cleaning agents.

3.5 PROTECTION

- A. Protect products of this section from damage caused by subsequent construction until substantial completion.
- B. Repair damaged or defective products to original specified condition in accordance with manufacturer's recommendations.
- C. Replace damaged or defective products that cannot be repaired to Architect's acceptance.

END OF SECTION 08 11 16

SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Solid-core doors with wood-veneer faces.
 - 2. Factory finishing flush wood doors.
 - 3. Factory fitting flush wood doors to frames and factory machining for hardware.
- B. Related Sections include the following:
 - 1. Division 8 Section "Hollow Metal Doors and Frames" for factory fitted doors installed in steel frames.
 - 2. Division 8 Section "Glazing" for glass view panels in flush wood doors.

1.3 SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate requirements for veneer matching.
 - 4. Indicate doors to be factory finished and finish requirements.
 - 5. Indicate fire ratings for fire doors.
- C. Samples for Initial Selection: For Factory-Finished Doors; Show the full range of colors available for finishes.
- D. Samples for Verification:
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.

- E. Sample Warranty: For special warranty.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.
- B. Quality Standard: Comply with NWWDA I.S.1-A, "Architectural Wood Flush Doors."
- C. Fire-Rated Wood Doors: Doors 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 NFPA 252.
 - 1. Test Pressure: Test at atmospheric pressure.
 - 2. Oversize, Fire-Rated Wood Doors: For door assemblies exceeding sizes of tested assemblies, provide oversize fire door label or certificate of inspection, from a testing and inspecting agency acceptable to authorities having jurisdiction, stating that doors comply with requirements of design, materials, and construction.
 - 3. Temperature-Rise Rating: At exit enclosures, provide doors that have a temperature-rise rating of 450 deg F (250 deg C) maximum in 30 minutes of fire exposure.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace doors that are defective in materials or workmanship, have warped (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section, or show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm) in a 75-mm span.
 - 1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 2. Warranty shall be in effect during the following period of time from date of Substantial Completion:
 - a. Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

FLUSH WOOD DOORS

2.1 MANUFACTURERS

- A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Marshfield Company; White Maple, or comparable product by one of the following:
 - 1. Eggers Industries; Architectural Door Division, White maple.
 - 2. Graham; White maple.
 - 3. VT Industries; White maple.
 - 4. Weyerhaeuser; White maple.

2.2 DOOR CONSTRUCTION, GENERAL

- A. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.
- B. Adhesives: Do not use adhesives containing urea formaldehyde.
- C. Composite Wood Products: Products shall be made without urea formaldehyde.
- D. Interior Veneer-Faced Doors for Transparent Finish:
 - 1. Grade: Premium, with Grade AA faces.
 - 2. Species: White Maple.
 - 3. Cut: Plain sliced (flat sliced).
 - 4. Match between Veneer Leaves: Slip match.
 - 5. Assembly of Veneer Leaves on Door Faces: Center balance match.
 - 6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 - 7. Core: Particleboard.
 - 8. Construction: Five plies with stiles and rails bonded to core, then entire unit abrasive planed before veneering.
 - 9. Stiles: Same species as faces.

2.3 SOLID-CORE DOORS

- A. Particleboard Cores: Comply with the following requirements:
 - 1. Particleboard: ANSI A208.1, Grade LD-2.
 - a. Use particleboard made with binder containing no urea-formaldehyde resin.
 - 2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
 - 3. Provide doors with either glued-block or structural composite lumber cores instead of particleboard cores at locations where exit devices are indicated.
- B. Structural-Composite-Lumber-Core Doors – (Where size of glazing requires use):
 - 1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf (3100 N).
- C. Fire-Rated Doors:

1. Construction: Construction and core specified above for type of face indicated or manufacturer's standard mineral-core construction as needed to provide fire rating indicated.
2. Blocking: For mineral-core doors, provide composite blocking with improved screw-holding capability approved for use in doors of fire ratings indicated as needed to eliminate through-bolting hardware.
3. Edge Construction: At hinge stiles, provide manufacturer's standard laminated-edge construction with improved screw-holding capability and split resistance and with outer stile matching face veneer.
4. Pairs: Furnish formed-steel edges and astragals for pairs of fire-rated doors, unless otherwise indicated.

2.4 LIGHT AND LOUVER FRAMES

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
 1. Wood Species: Same species as door faces.
 2. Profile: Manufacturer's standard shape.
 3. At 20-minute, fire-rated, wood-core doors, provide wood beads and metal glazing clips approved for such use.
- B. Metal Frames for Light Openings in Fire Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; factory primed and approved for use in doors of fire rating indicated.

2.5 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:
 1. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements in NFPA 80 for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: Factory cut and trim openings through doors.
 1. Light Openings: Trim openings with moldings of material and profile indicated.

2.6 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:
1. Grade: Premium.
 2. Finish: WDMA TR-6 catalyzed polyurethane.
 3. Staining: As indicated.
 4. Effect: Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores.
 5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames before hanging doors.
1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumbjamb.
 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 08 71 00 "Door Hardware."
- B. Manufacturer's Written Instructions: Install doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

- A. Operation: Re-hang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Access doors and frames for walls and ceilings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Detail fabrication and installation of access doors and frames for each type of substrate.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
 - 2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acudor Products, Inc.
 2. Elmdor/Stoneman Manufacturing Company; a division of Acorn Engineering Company.
 3. JL Industries, Inc.; a division of the Activar Construction Products Group.
 4. Karp Associates, Inc.
 5. Larsens Manufacturing Company.
 6. Nystrom, Inc.
- B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.
- C. Flush Access Doors with Exposed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
 2. Locations: Wall surfaces in masonry construction and ceiling surfaces in gypsum board.
 3. Door Size: 24 inches square, unless otherwise indicated.
 4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage.
 - a. Finish: Factory prime.
 5. Frame Material: Same material, thickness, and finish as door.
 6. Hinges: Spring-loaded, concealed-pin type.
 7. Hardware: Lock.
- D. Flush Access Doors with Concealed Flanges: In addition to access doors shown on the Drawings, provide 10 additional flush access doors to be installed as directed by the Architect.
1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
 2. Locations: Wall and ceiling surfaces in gypsum board.
 3. Door Size: 24 inches square, unless otherwise indicated.
 4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage.
 - a. Finish: Factory prime.
 5. Frame Material: Same material and thickness as door.
 6. Hinges: Spring-loaded, concealed-pin type.
 7. Hardware: Lock.
- E. Fire-Rated, Flush Access Doors with Exposed Flanges: In addition to access doors shown on the Drawings, provide 10 additional fire-rated access doors to be installed as directed by the Architect.
1. Assembly Description: Fabricate door to fit flush to frame, uninsulated. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
 2. Locations: Wall and ceiling.
 3. Door Size: 24 inches square, unless otherwise indicated.
 4. Fire-Resistance Rating: Not less than that of adjacent construction.
 5. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage.
 - a. Finish: Factory prime.

6. Frame Material: Same material, thickness, and finish as door.
7. Hinges: Spring-loaded, concealed-pin type.
8. Hardware: Lock.

F. Hardware:

1. Lock: Cylinder.

2.3 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- C. Frame Anchors: Same type as door face.
- D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
 2. Provide mounting holes in frames for attachment of units to metal framing.
 3. Provide mounting holes in frame for attachment of masonry anchors.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 1. For cylinder locks, furnish two keys per lock and key all locks alike.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Steel and Metallic-Coated-Steel Finishes:
 - 1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Install doors flush with adjacent finish surfaces.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13

SECTION 08 33 23 - SECTIONAL

DOORS 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 electrically operated sectional doors.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of sectional door and accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 4. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied finishes.
 - 1. Include Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
 - 1. Flat door sections.

- E. Delegated-Design Submittal: For sectional doors 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. Summary of forces and loads on walls and jambs.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sectional doors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines, Illinois Accessibility Code, and ICC A117.1.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Failure of components or operators before reaching required number of operation cycles.
 - c. Faulty operation of hardware.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
 - e. Delamination of exterior or interior facing materials.
 - 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain sectional doors from single source from single manufacturer.
 - 1. Obtain operators and controls from sectional door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Sectional doors shall comply with 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, Exterior Doors: Capable of withstanding the design wind loads.
 - 1. Design Wind Load: As indicated on Drawings.
 - 2. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components.
 - a. Deflection of door sections in horizontal position (open) shall not exceed 1/120 of the door width.
 - b. Deflection of horizontal track assembly shall not exceed 1/20 of the door width.
 - 3. Operability under Wind Load: Design overhead coiling doors to remain operable under design wind load, acting inward and outward.

2.3 STEEL DOOR ASSEMBLY

- A. Steel Sectional Door: Sectional door formed with hinged sections and fabricated according to DASMA 102 unless otherwise indicated.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Thermal Seal Standard TM175 by Raynor Door, or comparable product by one of the following:
 - a. Fimbel Architectural Door Specialties.
 - b. Overhead Door Corporation.
 - c. Equal product approved by Architect in an addendum.
- B. Operation Cycles: Door components and operators capable of operating for not less than 50,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
- C. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. (0.406 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h).
- D. R-Value: 16.0 deg F x h x sq. ft./Btu (2.818 K x sq. m/W).

- E. Steel Sections: Zinc-coated (galvanized) steel sheet with G60 (Z180) zinc coating.
 - 1. Section Thickness: 1-3/4 inches (44 mm).
 - 2. Exterior-Face, Steel Sheet Thickness: 0.018-inch- (0.45-mm-) minimum nominal coated thickness.
 - a. Surface: Flat.
 - b. Surface: Manufacturer's standard, stucco embossed.
 - 3. Insulation: Foamed in place.
 - 4. Interior Facing Material: Zinc-coated (galvanized) steel sheet with a nominal coated thickness of 0.013 inch (0.31 mm) minimum.
 - F. Track Configuration: High-lift track.
 - G. Weatherseals: Fitted to bottom and top and around entire perimeter of door. Provide combination bottom weatherseal and sensor edge.
 - H. Roller-Tire Material: Manufacturer's standard.
 - I. Counterbalance Type: Torsion spring.
 - J. Electric Door Operator:
 - 1. Usage Classification: Medium duty, up to 12 cycles per hour and up to 50 cycles per day.
 - 2. Operator Type: Trolley.
 - 3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.
 - 4. Motor Exposure: Interior, clean, and dry.
 - 5. Emergency Manual Operation: Push-up type.
 - 6. Obstruction-Detection Device: Automatic electric sensor edge on bottom section; self-monitoring type.
 - a. Sensor Edge Bulb Color: Black.
 - 7. Control Station: Interior-side mounted.
 - 8. Other Equipment: Audible and visual signals and Portable, radio-control system.
 - K. Door Finish:
 - 1. Baked-Enamel or Powder-Coat Finish: Color and gloss as selected by Architect from manufacturer's full range.
 - 2. Finish of Interior Facing Material: White or Grey.
- 2.4 FULL VISION DOOR ASSEMBLY
- A. Full-Vision Aluminum Sectional Door: Sectional door formed with hinged sections and fabricated according to DASMA 102 unless otherwise indicated.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide AlumaView AV2000 by Raynor Door, or comparable product by one of the following:

- a. Fimbel Architectural Door Specialties.
 - b. Hass Door, A Nofziger Company; Model CA-110.
 - c. Overhead Door Corporation; Model 521.
- B. Operation Cycles: Door components and operators capable of operating for not less than 50,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
- C. Aluminum Sections: Full vision.
1. Material: Extruded aluminum, 2 inch (51 mm) thick stile and rail. ASTM B221, 6063-T5 or T6 alloy and temper.
 2. Clear Tempered Glass: 6 mm thick and complying with ASTM C 1048, Kind FT, Type II, Class 1, Quality Q3.
- D. Track Configuration: High-lift track.
- E. Roller-Tire Material: Case-hardened steel.
- F. Counterbalance Type: Torsion spring.
- G. Electric Door Operator:
1. Usage Classification: Medium duty, up to 12 cycles per hour and up to 50 cycles per day.
 2. Operator Type: Jack shaft, mounting per Architect's selection.
 3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.
 4. Motor Exposure: Interior, clean, and dry.
 5. Emergency Manual Operation: Push-up type.
 6. Obstruction-Detection Device: Automatic photoelectric sensor and sensor edge on bottom section.
 - a. Sensor Edge Bulb Color: Black.
 7. Control Station: Interior-side mounted.
- H. Door Finish:
1. Aluminum Finish: Clear anodized.
 2. Finish of Interior Facing Material: Match finish of exterior section face.

2.5 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 STEEL DOOR SECTIONS

- A. Exterior Section Faces and Frames: Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated zinc coating and thickness.
1. Fabricate section faces from single sheets to provide sections not more than 24 inches

- (610 mm) high and of indicated thickness. Roll horizontal meeting edges to a continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove weather-resistant seal, with a reinforcing flange return.
2. For insulated doors, provide sections with continuous thermal-break construction, separating the exterior and interior faces of door.
- B. Section Ends and Intermediate Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet not less than 0.064-inch- (1.63-mm-) nominal coated thickness and welded to door section. Provide intermediate stiles formed from not less than 0.064-inch- (1.63-mm-) thick galvanized-steel sheet, cut to door section profile, and welded in place. Space stiles not more than 48 inches (1219 mm) apart.
 - C. Reinforce bottom section with a continuous channel or angle conforming to bottom-section profile.
 - D. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place.
 - E. Provide reinforcement for hardware attachment.
 - F. Foamed-in-Place Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free polyurethane insulation, foamed in place to completely fill interior of section and pressure bonded to face sheets to prevent delamination under wind load, and with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within steel sections and the interior facing material, with no exposed insulation.
 - G. Interior Facing Material: Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated thickness.
 - H. Fabricate sections so finished door assembly is rigid and aligned, with tight hairline joints and free of warp, twist, and deformation.
- 2.7 ALUMINUM DOOR SECTIONS
- A. Sections: Extruded-aluminum stile and rail members with dimensions and profiles as indicated on Drawings; members joined by welding or with concealed, 1/4-inch- (6-mm-) minimum diameter, aluminum or nonmagnetic stainless-steel through bolts, full height of door section; and with meeting rails shaped to provide a weather-resistant seal.
 1. Aluminum: ASTM B 221 (ASTM B 221M) extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; minimum thickness 0.063 inch (1.6 mm) for door section 1-3/4 inches (44 mm) deep, and as required to comply with requirements.
 2. Reinforce or form trusses within sections as required to stiffen door and for wind loading.
 3. Provide reinforcement for hardware attachment.
 - B. Full-Vision Sections: Manufacturer's standard, tubular, aluminum-framed section fully glazed with 6-mm-thick, clear tempered glazing set in vinyl, rubber, or neoprene glazing channel and with removable extruded-vinyl or aluminum stops.

2.8 TRACKS, SUPPORTS, AND ACCESSORIES

- A. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances indicated on Drawings, Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides for required door type, size, weight, and loading.
1. Galvanized Steel: ASTM A 653/A 653M, minimum G60 (Z180) zinc coating.
 2. Slope tracks at an angle from vertical or design tracks to ensure tight closure at jambs when door unit is closed.
 3. Track Reinforcement and Supports: Galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced 2 inches (51 mm) apart for door-drop safety device.
 - a. For Vertical Track: Intermittent, jamb brackets attached to track and attached to wall.
 - b. For Horizontal Track: Continuous reinforcing angle from curve in track to end of track, attached to track and supported at points by laterally braced attachments to overhead structural members.
- B. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.

2.9 HARDWARE

- A. General: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.
- B. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch- (2.01-mm-) nominal coated thickness at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible. Provide double-end hinges where required, for doors more than 16 feet (4.88 m) wide unless otherwise recommended by door manufacturer.
- C. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 3-inch- (76-mm-) diameter roller tires for 3-inch- (76-mm-) wide track and 2-inch- (51-mm-) diameter roller tires for 2-inch- (51-mm-) wide track.
- D. Push/Pull Handles: Equip each push-up operated or emergency-operated door with galvanized-steel lifting handles on each side of door, finished to match door.

2.10 COUNTERBALANCE MECHANISM

- A. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from steel-spring wire complying with ASTM A 229/A 229M, mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.
- B. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft. Provide one additional midpoint bracket for shafts up to 16 feet (4.88 m) long and

two additional brackets at one-third points to support shafts more than 16 feet (4.88 m) long unless closer spacing is recommended by door manufacturer.

- C. Cables: Galvanized-steel, multistrand, lifting cables with cable safety factor of at least 5 to 1.
- D. Cable Safety Device: Include a spring-loaded steel or spring-loaded bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if either lifting cable breaks.
- E. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
- F. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.

2.11 MANUAL DOOR OPERATORS

- A. General: Equip door with manual door operator by door manufacturer.
- B. Push-up Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf (111 N).

2.12 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and "operation cycles" requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Door-Operator Type: Unit consisting of electric motor, gears, pulleys, belts, sprockets, chains, and controls needed to operate door and meet required usage classification.
 - 1. Sectional Steel Door: Trolley operator mounted to ceiling above and to rear of door in raised position and directly connected to door with drawbar.
 - 2. Sectional Aluminum Door: Jackshaft operator mounted on the inside front wall and connected to torsion shaft with an adjustable coupling or drive chain.
- D. Motors: Reversible-type motor for motor exposure indicated.
 - 1. Electrical Characteristics:
 - a. Phase: Single phase.
 - b. Volts: 115 V.

- c. Hertz: 60.
 - 2. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
 - 3. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 - 4. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
 - 5. Use adjustable motor-mounting bases for belt-driven operators.
- E. Limit Switches: Equip motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
- F. Obstruction Detection Device: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.
- 1. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom section. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Self-Monitoring Type: Four-wire configured device designed to interface with door-operator control circuit to detect damage to or disconnection of sensor edge.
- G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure, push-button control labeled "Close."
- 1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
- H. Emergency Manual Operation: Equip electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N).
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.

2.13 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" 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.

2.14 STEEL AND GALVANIZED-STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

2.15 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Tracks:
 - 1. Fasten vertical track assembly to opening jambs and framing, spaced not more than 24 inches (610 mm) apart.
 - 2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.
- C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.
- D. Power-Operated Doors: Install according to UL 325.

3.3 STARTUP SERVICES

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust doors and seals to provide weather-resistant fit around entire perimeter.
- D. Touch-up Painting: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A 780/A 780M.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION 08 33 23

SECTION 08 33 26 - OVERHEAD COILING

GRILLES PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Open-curtain overhead coiling grilles.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports and angle-framing of grille opening.

1.2 SUBMITTALS

A. Product Data: For each type and size of overhead coiling grille and accessory. Include the following:

1. Construction details, material descriptions, dimensions of individual components, profiles for curtain components, and finishes.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Maintenance Data: For overhead coiling grilles to include in maintenance manuals.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Source Limitations: Obtain overhead coiling grilles from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling grille manufacturer.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Operation Cycles: Provide overhead coiling grille components and operators capable of operating for not less than number of cycles indicated for each grille. One operation cycle is complete when a grille is opened from the closed position to the fully open position and returned to the closed position.

2.2 GRILLE CURTAIN MATERIALS AND CONSTRUCTION

- A. Open-Curtain Grilles: Fabricate metal grille curtain as an open network of horizontal rods, spaced at regular intervals, that are interconnected with vertical links, which are formed and spaced as indicated and are free to rotate on the rods.
 - 1. Aluminum Grille Curtain: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- B. Endlocks: Continuous end links, chains, or other devices at ends of rods; locking and retaining grille curtain in guides against excessive pressures, maintaining grille curtain alignment, and preventing lateral movement.
- C. Bottom Bar: Manufacturer's standard continuous channel or tubular shape, finished to match grille.
 - 1. Astragal: Equip each grille bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
 - 2. Provide motor-operated grilles with combination bottom astragal and sensor edge.
- D. Grille Curtain Jamb Guides: Manufacturer's standard shape having curtain groove with return lips or bars to retain curtain. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise; with removable stops on guides to prevent overtravel of curtain.
 - 1. Removable Posts and Jamb Guides: Manufacturer's standard.

2.3 LOCKING DEVICES

- A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
 - 1. Lock Cylinders: Cylinders specified in Section 087100 "Door Hardware".
 - 2. Keys: Two for each cylinder.

- B. Safety Interlock Switch: Equip power-operated grilles with safety interlock switch to disengage power supply when grille is locked.

2.4 COUNTERBALANCING MECHANISM

- A. General: Counterbalance grilles by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of parts and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.
- C. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.5 ELECTRIC GRILLE OPERATORS

- A. General: Electric grille operator assembly of size and capacity recommended and provided by grille manufacturer for grille and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking grille, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each grille.
- C. Grille Operator Location(s): Operator location indicated for each grille.
 - 1. Front-of-Hood Mounted: Operator is mounted to the right or left grille head plate with the operator on coil side of the grille-hood assembly and connected to the grille drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
- D. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 11 Section "Common Motor Requirements for Equipment" unless otherwise indicated.
 - 1. Electrical Characteristics:

- a. Phase: Single phase.
 - b. Volts: 208 V.
 - c. Hertz: 60.
2. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
 3. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate grille in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
 4. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 5. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
- E. Limit Switches: Equip each motorized grille with adjustable switches interlocked with motor controls and set to automatically stop grille at fully opened and fully closed positions.
- F. Obstruction Detection Device: Equip motorized grille with indicated external automatic safety sensor capable of protecting full width of grille opening. Activation of sensor immediately stops and reverses downward grille travel.
1. Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Self-Monitoring Type: Four-wire configured device designed to interface with grille operator control circuit to detect damage to or disconnection of sensing device.
- G. Remote-Control Station: Key operated.
- H. Emergency Manual Operation: Equip each electrically powered grille with capability for emergency manual operation. Design manual mechanism so required force for grille operation does not exceed 25 lbf (111 N).
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.
- 2.6 OPEN-CURTAIN GRILLE ASSEMBLY
- A. Open-Curtain Grille: Overhead coiling grille with a curtain having a network of horizontal rods that interconnect with vertical links.
1. Product: Subject to compliance with requirements, provide product by one of the following:

- a. Cookson Company; 670.
 - b. Cornell Iron Works, Inc.
 - c. McKeon Rolling Steel Door Company, Inc.
 - d. Overhead Door Corporation.
 - e. Raynor.
 - f. Equal product approved by Architect in an addendum.
- B. Operation Cycles: Not less than 20,000.
1. Include tamperproof cycle counter.
- C. Grille Curtain Material: Aluminum.
1. Space rods at approximately 2 inches (51 mm) o.c.
 2. Link Spacing: Approximately 9 inches (228 mm) apart in a straight in-line pattern.
 3. Spacers: Metal tubes matching curtain material.
- D. Curtain Jamb Guides: Manufacturer's standard with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise. Provide r post(s) and jamb guides as required for exit door assembly.
- E. Locking Devices: Equip grille with locking device assembly.
1. Locking Device Assembly: locking bars, operable from inside and outside with cylinders.
- F. Grille Finish:
1. Aluminum Finish: Mill.

2.7 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.

2.8 ALUMINUM FINISHES

- A. Mill Finish: Manufacturer's standard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install overhead coiling grilles and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Install overhead coiling grilles, hoods, and operators at the mounting locations indicated for each grille.
- C. Accessibility: Install overhead coiling grilles, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.3 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Test grille opening when activated by detector, fire-alarm system, emergency-egress release, or self-opening mechanism as required. Reset grille-opening mechanism after successful test.

3.4 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that grilles operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling grilles.

END OF SECTION 083326

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Storefront framing.
 - 2. Manual-swing entrance doors.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 - 4. Include point-to-point wiring diagrams showing the following:
 - a. Power requirements for each electrically operated door hardware.
 - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.

- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
 - 1. Joinery, including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
- F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- G. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Preconstruction Laboratory Mockup Testing Submittals:
 - 1. Testing Program: Developed specifically for Project.
 - 2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
 - 3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.
- B. Qualification Data: For Installer.
- C. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
 - 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- D. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by a qualified testing agency.
- E. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C1401. Include periodic quality-control reports.
- F. Source quality-control reports.
- G. Field quality-control reports.
- H. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Laboratory Mockup Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated.
- C. Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated.
- D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.8 MOCKUPS

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts 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:
 - a. Structural failures, including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.

- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing, spandrel panels, and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
 1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.

- D. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding $1/175$ of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to $3/4$ inch (19.1 mm), whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to $1/360$ of clear span or $1/8$ inch (3.2 mm), whichever is smaller.
 - a. Operable Units, if shown: Provide a minimum $1/16$ -inch (1.6-mm) clearance between framing members and operable units.
 3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
 - a. Perpendicular to Plane of Wall: No greater than $1/240$ of clear span plus $1/4$ inch (6.35 mm) for spans greater than 11 feet 8- $1/4$ inches (3.6 m) or $1/175$ times span, for spans of less than 11 feet 8- $1/4$ inches (3.6 m).
- E. Structural: Test according to ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Air Infiltration: Test according to ASTM E283 for infiltration as follows:
1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 2. Entrance Doors:
 - a. 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).
- G. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
- H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
 2. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

- I. Seismic Performance if required: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.
- J. Energy Performance: Certify and label energy performance according to NFRC as follows:
 - 1. Thermal Transmittance (U-factor): Fixed glazing and framing areas as a system shall have U-factor of not more than 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K) as determined according to NFRC 100.
 - 2. Solar Heat Gain Coefficient (SHGC): Fixed glazing and framing areas as a system shall have SHGC of no greater than 0.45 as determined according to NFRC 200.
 - 3. Condensation Resistance: Fixed glazing and framing areas as a system shall have an NFRC-certified condensation resistance rating of no less than 65 as determined according to NFRC 500.
- K. Noise Reduction: Test according to ASTM E90, with ratings determined by ASTM E1332, as follows.
 - 1. Outdoor-Indoor Transmission Class: Minimum 30.
- L. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996.
- M. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
 - 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
 - b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C)
 - c. Interior Ambient-Air Temperature: 75 deg F (24 deg C).
- N. Structural-Sealant Joints:
 - 1. Designed to carry gravity loads of glazing.
- O. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed, aluminum-framed entrances and storefronts without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
 - 1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 - 2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.3 STOREFRONT SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer North America; an Alcoa company; 451T or a comparable product by one of the following:
1. EFCO Corporation.
 2. Oldcastle BuildingEnvelope™.
 3. Tubelite Inc.
 4. Wausau Window and Wall Systems.
- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Exterior Framing Construction: Thermally broken.
 2. Interior Vestibule Framing Construction: Nonthermal.
 3. Glazing System: Retained mechanically with gaskets on four sides.
 4. Glazing Plane: Center.
 5. Finish: Clear anodic finish unless otherwise shown.
 6. Fabrication Method: Field-fabricated stick system.
 7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 8. Steel Reinforcement: As required by manufacturer.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
1. Overall Panel Thickness: As indicated.
 2. Exterior Skin: Aluminum.
 - a. Thickness: Manufacturer's standard for finish and texture indicated.
 - b. Finish: Match framing system.
 - c. Texture: Smooth.
 - d. Backing Sheet: 1/8-inch- (3.2-mm-) thick tempered hardboard.
 3. Interior Skin: Aluminum.
 - a. Thickness: Manufacturer's standard for finish and texture indicated.
 - b. Finish: Matching storefront framing.
 4. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
 5. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2.4 ENTRANCE DOOR SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer North America; an Alcoa company; 451T or a comparable product by one of the following:
 - 1. EFCO Corporation.
 - 2. Oldcastle BuildingEnvelope™.
 - 3. Tubelite Inc.
 - 4. Wausau Window and Wall Systems.
- B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
 - 1. Door Construction: 1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch-(3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
 - 2. Door Design: As indicated.
 - 3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.

2.5 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00 "Door Hardware."

2.6 GLAZING

- A. Glazing: Comply with Section 08 80 00 "Glazing."

2.7 ACCESSORIES

- A. Automatic Door Operators, if shown.
- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- D. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.
- F. Rigid PVC Filler.

2.8 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. 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.
- C. Fabricate components that, when assembled, have the following characteristics:
 1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Physical and thermal isolation of glazing from framing members.
 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 1. At interior and exterior doors, provide compression weather stripping at fixed stops.
- G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 2. At exterior doors, provide weather sweeps applied to door bottoms.
- H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker unless otherwise shown.

2.10 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare surfaces that are in contact with 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.

3.3 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 and to prevent impeding movement of moving joints.
 - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.

- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install glazing as specified in Section 08 80 00 "Glazing."
- G. Install weatherseal sealant according to Section 07 92 00 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
- H. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
 - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 - 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
 - 1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
 - 2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
 - 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
 - c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
 - 4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.
 - 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
 - a. Perform a minimum of two tests in areas as directed by Architect.
 - 2. Air Infiltration: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Perform a minimum of two tests in areas as directed by Architect.

3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
- C. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
 1. Test a minimum of two areas on each building facade.
 2. Repair installation areas damaged by testing.
- D. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 MAINTENANCE SERVICE

- A. Entrance Door Hardware:
 1. 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 entrance door hardware.
 2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

3.7 ENTRANCE DOOR HARDWARE SETS TO BE ADDED

END OF SECTION 08 41 13

SECTION 08 44 13 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes glazed aluminum curtain walls.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Sunshades.
 - f. Flashing and drainage.
 - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

1.6 WARRANTY

- A. Special Assembly Warranty: Manufacturer agrees to repair or replace components of glazed aluminum curtain wall 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:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 - 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - 2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazed aluminum curtain walls.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
- E. Structural: Test according to ASTM E 330 as follows:
 - 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
- H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (480 Pa).
 2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- I. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) as determined according to NFRC 100.
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.40 as determined according to NFRC 200.
- J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
 - b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer North America; an Alcoa company; 1600 wall system 1 or a comparable product by one of the following:
 - 1. EFCO Corporation.
 - 2. Oldcastle BuildingEnvelope™.
 - 3. Tubelite Inc.
 - 4. Wausau Window and Wall Systems.
 - 5. Equal product approved by Architect in an addendum.
- B. Source Limitations: Obtain all components of curtain wall system, including framing and accessories, from single manufacturer.

2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Construction: Thermally broken.
 - 2. Glazing System: Retained mechanically with gaskets on four sides.
 - 3. Glazing Plane: Front.
 - 4. Finish: Baked-enamel or powder-coat finish.
- B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
 - 1. Include snap-on aluminum trim that conceals fasteners.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 - 2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.

- b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
- c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 ENTRANCES

- A. Entrances: Comply with Section 084113 "Aluminum-Framed Entrances and Storefronts."

2.5 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.
- D. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less.
- E. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
 - 1. Color: Match structural sealant.

2.6 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

E. Sheet Materials:

1. Elastomeric membrane system:
 - a. Silicone Transition System: Dow Corning 123.
 - b. Rubbergard System as manufactured by Firestone.

2.7 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. 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.
- C. Fabricate components that, when assembled, have the following characteristics:
 1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Physical and thermal isolation of glazing from framing members.
 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 5. Provisions for field replacement of glazing from exterior.
 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Fabricate components to resist water penetration as follows:
 1. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
- E. Curtain-Wall Framing: Fabricate components for assembly using manufacturer's standard assembly method.
- F. Factory-Assembled Frame Units:
 1. Rigidly secure nonmovement joints.
 2. Prepare surfaces that are in contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
 3. Preparation includes, but is not limited to, cleaning and priming surfaces.
 4. Seal joints watertight unless otherwise indicated.
 5. Install glazing to comply with requirements in Section 088000 "Glazing."
- G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- 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.

3.3 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 and to prevent impeding movement of moving joints.
 - 6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
 - 7. Seal joints watertight unless otherwise indicated.
- B. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
 - 2. Where aluminum is in 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 glazed aluminum curtain wall to exterior.
- D. Install components plumb and true in alignment with established lines and grades.

- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install glazing as specified in Section 088000 "Glazing."
 - 1. 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.
- G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
 - 1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
 - 2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
 - 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
 - c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
 - 4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.5 FIELD QUALITY CONTROL

- A. Field Quality-Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.
 - 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

- B. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 08 44 13

SECTION 08 44 23 - STRUCTURAL-SEALANT-GLAZED CURTAIN WALLS

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. Field-glazed, two-sided structural-sealant-glazed curtain-wall assemblies.

B. Related Sections:

- 1. Section 08 44 13 "Glazed Aluminum Curtain Walls" for conventionally glazed curtain walls.
- 2. Section 08 91 19 "Fixed Louvers" for units installed with structural-sealant-glazed curtain walls.

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by preconstruction testing manufacturer's standard of structural-sealant-glazed curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Structural-sealant-glazed curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.

- B. Delegated Design: Design structural-sealant-glazed curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings.
- D. Structural-Test Performance: Test according to ASTM E 330 as follows:
 - 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- E. Deflection of Framing Members: At design wind pressure, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
 - 3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.
 - 4. Test Performance: Meeting criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.
- F. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
- G. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (480 Pa).
 - 1. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.

- H. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
 - 2. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
 - 3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

 - I. Energy Performance: Structural sealant glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.
 - 1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) as determined according to NFRC 100.

 - J. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than 71_{frame}.

 - K. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
 - 1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 - 2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

 - L. Structural-Sealant Joints:
 - 1. Designed to carry gravity loads of glazing.
 - 2. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).
 - 3. Design reviewed and approved by structural-sealant manufacturer.
- 1.4 ACTION SUBMITTALS
- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Shop Drawings: For structural-sealant-glazed curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each vertical-to-horizontal intersection of structural-sealant-glazed curtain walls, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - 3. Include laboratory mockup Shop Drawings, prepared by a qualified preconstruction testing agency, showing details of laboratory mockup.
 - a. Resubmit Shop Drawings with changes made to details of structural-sealant-glazed curtain walls, to successfully complete preconstruction testing.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
 - 1. Joinery, including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
- E. Delegated-Design Submittal: For structural-sealant-glazed curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Preconstruction Mockup Submittals:
 - 1. Preconstruction Testing Program: Developed specifically for Project.
 - 2. Preconstruction Test Reports: Prepared by a qualified preconstruction testing agency, for each mockup test.
 - 3. Photographs:
 - a. Take a minimum of 10 photographs at locations and intervals as required by Architect.

- b. Submit digital color images on CD-R of mockup before, during, and after preconstruction testing.
- 4. Record Drawings: Submit record drawings of preconstruction mockups prepared by preconstruction testing agency.
- B. Field quality-control reports.
- C. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C 1401 recommendations for postinstallation-phase quality-control program.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for assemblies' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
- D. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of structural-sealant-glazed curtain walls.
- E. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- F. Energy-Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
 - 1. Provide NFRC-certified, structural-sealant-glazed curtain walls with an attached label.
- G. Preinstallation Conference: Conduct conference at Project site.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for structural-sealant-glazed curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

- A. Special Assembly Warranty: Standard form in which manufacturer agrees to repair or replace components of structural-sealant-glazed curtain walls 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:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 - 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - 2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer North America; an Alcoa company; Series 1600 Wall System 2 or a comparable product by one of the following:
 - 1. EFCO Corporation.
 - 2. Oldcastle Building Envelope™.
 - 3. Tubelite Inc.
 - 4. Wausau Window and Wall Systems.
 - 5. Equal product approved by Architect in an addendum.

2.2 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 - 4. Structural Profiles: ASTM B 308/B 308M.
 - 5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
 - 1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 FRAMING

- A. Framing Members: Manufacturer's standard formed- or extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.

- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

- C. Anchors: Three-way adjustable anchors, with minimum adjustment of 1 inch (25.4 mm), that accommodate fabrication and installation tolerances in material and finish and are compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

- D. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

- E. Framing Sealants: Manufacturer's standard sealants.

2.4 GLAZING

- A. Glazing: Comply with Section 08 80 00 "Glazing."
- B. Glazing Gaskets, Spacers, Setting Blocks, Sealant Backings, and Bond Breakers: Manufacturer's standard permanent, nonmigrating types compatible with sealants and suitable for joint movement and assembly performance requirements.
- C. Glazing Gaskets, Spacers, Setting Blocks, Sealant Backings, and Bond Breakers: As specified in Section 08 80 00 "Glazing."
- D. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less.
- E. Glazing Sealants: For structural-sealant-glazed curtain walls, as recommended by manufacturer for joint type, and as follows:
 - 1. Structural Sealant: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
 - a. Color: Black.
 - 2. Weatherseal Sealant: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
 - a. Color: Matching structural sealant.

2.5 INSULATED SPANDREL PANELS

- A. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
 - 1. Overall Panel Thickness: As indicated.
 - 2. Exterior Skin: Aluminum.
 - a. Thickness: Manufacturer's standard for finish and texture indicated.
 - b. Finish: Match framing system.
 - c. Texture: Smooth.
 - d. Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard.
 - 3. Interior Skin: Aluminum.
 - a. Thickness: Manufacturer's standard for finish and texture indicated.
 - b. Finish: Matching storefront framing.

- c. Texture: Smooth.
 - d. Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard.
- 4. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; 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.

2.6 ACCESSORY MATERIALS

- A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.
- B. Cleaning Agent and Cloth: As recommended by structural-sealant manufacturer.
- C. Sheet Materials:
 - 1. Elastomeric membrane system:
 - a. Silicone Transition System: Dow Corning 123.
 - b. Rubbergard System as manufactured by Firestone.

2.7 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. 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.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
 - 6. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels. Include accommodations for using temporary support device (dutchman) to retain glazing in place while sealant cures.

7. Provisions for safety railings mounted on interior face of mullions.
8. Components curved to indicated radii.
9. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within structural-sealant-glazed curtain wall to exterior.

D. Factory-Assembled Frame Units:

1. Rigidly secure nonmovement joints.
2. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
3. Preparation includes, but is not limited to, cleaning and priming surfaces.
4. Seal joints watertight unless otherwise indicated.
5. Install glazing to comply with requirements in Section 08 80 00 "Glazing."

E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm.

2.9 SOURCE QUALITY CONTROL

- A. Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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 nonmoving joints.

5. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.
6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
7. 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, applying sealant or tape, or 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 structural-sealant-glazed curtain walls to exterior.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 08 80 00 "Glazing." 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.

G. Install weatherseal sealant according to Section 07 92 00 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install to comply with the following nonaccumulating maximum tolerances:

1. Plumb: 1/8 inch in 10 feet (3 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
2. Level: 1/8 inch in 20 feet (3 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
 - c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).

4. Location: Limit variation from plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/2 inch (12.7 mm) over total length.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of representative areas of structural-sealant-glazed curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
 1. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
 - a. Test a minimum of four areas on each building facade.
 - b. Repair installation areas damaged by testing.
 2. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
 - a. Test Area: A minimum area of 75 feet (23 m) by one story of structural-sealant-glazed curtain wall.
- C. Structural-sealant-glazed curtain walls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 08 44 23

SECTION 08 71 00 – DOOR HARDWARE

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard Builders Hardware
2. Electrified Hardware
3. Hardware for Aluminum Doors
4. Automatic Operators, Low Energy
5. Thresholds and Weatherstripping
6. Templates
7. Hardware Schedule
8. Keying System

B. Related Sections:

1. Division 1 Section "Submittal Procedures"
2. Division 8 Section "Steel Doors and Frames"
3. Division 8 Section "Flush Wood Doors"
4. Division 8 Section "Aluminum Entrances and Storefront"
5. Division 26 Section "Electrical"

C. Products Supplied But Not Installed Under This Section:

1. Hardware for Aluminum Doors.

1.2 REFERENCES:

A. Reference and Standards: Where cited, and except as modified by Project Specifications, applicable standards of following organizations apply:

1. American National Standards Institute (ANSI)
2. Builders Hardware Manufacturers Association (BHMA)
3. Door Hardware Institute (DHI)
4. National Fire Protection Association (NFPA)
5. Steel Door Institute (SDI)
6. Underwriters Laboratories (UL)
7. Illinois Accessibility Code 1997
8. International Building Code 2006
9. Americans with Disability Act 2010

1.3 SYSTEM DESCRIPTION:**A. Performance Requirements:**

1. Provide hardware for fire-rated openings in compliance with NFPA 80.
2. Provide hardware tested and listed by Underwriters Laboratories or other approved testing agency.
3. Provide hardware for fire-rated openings conforming to UL10C positive pressure fire testing.

1.4 SUBMITTALS:**A. Make submittals in accord with Section 01 33 00.****B. Hardware Schedule:** Submit six copies of a typed vertical style hardware schedule on 8-1/2 x 11 sheets. Schedule openings by door number and locations. Indicate door and frame material, dimensions, hand, degree of opening, label condition and special information. Hardware items shall include product description and number, finish, hand, size, keying, template and special requirements. The scheduling sequence and format shall be as recommended by DHI.**C. Samples:** Upon Architect / Engineer's request, submit samples showing function, finish, and design of proposed hardware items. Samples remain suppliers property and will be returned to him prior to project completion.**D. Samples and Templates:** Furnish to manufacturer of wood and metal doors and frames as required for proper hardware reinforcement and preparation of their work. If required, furnish physical hardware to the door and frame manufacturer for preparation and/or application.**E. Catalog Cuts:** Submit two sets of each type of hardware item used.**F. Keying Schedule:** Prepared by or under the supervision of an Architectural Hardware Consultant detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.**G. Elevation Wiring Diagrams:**

1. Include with the hardware schedule submittal elevation wiring diagrams of each different electrified hardware application.
2. Schedules submitted without this requirement will be considered incomplete and will not be reviewed.

H. Wiring Diagrams, Point-to-Point:

1. Provide point to point wiring diagrams after hardware schedule submittal has been reviewed and returned and accepted as conforming to contract

documents. Provide a complete description of the electrified hardware operation for each different electrified hardware application.

- I. Certifications: Arrange for hardware supplier to visit site and certify following:
 - 1. Hardware is installed and operating in a satisfactory manner.
 - 2. Hardware installed is as listed on the contract documents.
 - 3. Submit certifications in writing addressed to User in care of Architect.

- J. Contract Close-Out Submittal:
 - 1. Provide the following material in both electronic format (pdf) and a 3-ring binder clearly tabbed and organized:
 - a. Final hardware schedule
 - b. Final key schedule
 - c. Catalog Cuts
 - d. Warrantees

1.5 QUALITY ASSURANCE:

- A. Qualifications:
 - 1. Contractor is responsible for:
 - a. Proper application and fit of door and specialty hardware in locations as indicated on drawings or as specified.
 - b. Items not specifically mentioned, but necessary to complete work are to be furnished matching in quality and finish of specified items in similar locations.
 - c. Coordinate dimensions between hardware items.
 - d. Furnish and install only hardware items listed on approved door hardware submittal.

 - 2. Contractor's selection of hardware supplier:
 - a. Select recognized builders hardware supplier who has been furnishing hardware in area of project for a period not less than five years.
 - b. Recognized supplier to have on staff an Architectural Hardware Consultant (AHC) certified by the Door and Hardware Institute. Provide a copy of the AHC certification with submittals.
 - c. Hardware supplier's AHC to be available at all reasonable times during course of work to meet personally with User, Architect or Contractor for hardware consultation.

- B. Electrified Hardware:
1. Unless noted otherwise in Division 16 provide electrified hardware items rated 24 VDC.
 2. Coordinate electrical hardware requirements, with Division 16 and 17 work for electrical distribution, fire alarm, and security systems.
- C. Automatic Operators:
1. Supplier to provide Factory Trained and Certified Technicians to install automatic operators, actuators, provide drawings interfacing electrified hardware and access control systems, provide end user training and be available for continuing support during the warranty period. Provide a copy of certification training with the submittals.
- D. Pre Installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to electrified door hardware including, but not limited to, the following:
1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
 2. Review sequence of operation for each type of electrified door hardware.
 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Review required testing procedures.
- E. Keying Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." In addition to User, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 2. Preliminary key system schematic diagram.
 3. Address for delivery of keys.

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Delivery: Deliver items in manufacturer's original package. Each item individually packaged and carefully marked for intended opening and use. Each item complete with necessary screws, bolts, keys, instructions, and where necessary, installation templates.

- B. Storage: Protect materials on the job and during installation. Provide a secure, locked, dry storage area or room in the building. Store off the floor on temporary shelving.
- C. Handling: Handle items in a manner to prevent damage. Marred, defaced, damaged, and defective items will be rejected.

1.7 WARRANTY:

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking or breakage.
 - b. Faulty operation of operators and door hardware.
 - c. Deterioration of metals, metal finishes and other materials beyond normal weathering and use.
 - 2. Warranty Period: One year from date of Substantial Completion, except as follows:
 - a. Continuous Hinges: 10 years from date of substantial completion.
 - b. Exit Devices: Three years from date of substantial completion.
 - c. Manual Closers: 30 years from date of substantial completion.
 - d. Door Closers with Electric Components – 2 years from date of substantial completion.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Finish a complete set of specialized tools and maintenance instructions as needed for User's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 – PRODUCTS

2.1 MANUFACTURERS:

- A. Catalog numbers of Manufacturers listed in Column 1 have been used to establish quality required. Manufacturers listed in Columns 2&3 are approved substitutes.
- B. It is the intent that approved door hardware be provided for every door on the project. Doors inadvertently omitted from the schedule shall be provided with hardware equal to doors of similar function.

<u>ITEM</u>	<u>1</u>	<u>2</u>	<u>3</u>
Hinges	Hager	No Substitutes	
Continuous Hinges	Hager	No Substitutes	
Locks	Schlage	No Substitutes	
Sliding Door Locks	Accurate	No Substitutes	
Exit Devices	Von Duprin	No Substitutes	
Closers	LCN	No Substitutes	
Push, Pull, Kick Plates	Hager	No Substitutes	
Overhead Stops	GJ	No Substitutes	
Stops, Flush Bolts	Hager	No Substitutes	
Weatherstrip, Thresholds	National	No Substitutes	
Sliding Door Hardware	R-W	No Substitutes	

C. Designations: Following abbreviations to identify list manufacturers.

Accurate	Accurate Lock and Hardware, Stamford, CT.
GJ	Glynn-Johnson Corp., Indianapolis, IN
Hager	C. Hager & Sons, St. Louis, MO
LCN	LCN Closers, Princeton, IL
National	National Guard, Memphis, TN
R-W	Richards-Wilcox, Aurora, IL.
Schlage	Schlage Lock, Security, CO.
Von Duprin	Von Duprin, Indianapolis, IN

2.2 MATERIALS:

A. SCREWS & FASTENERS:

1. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - a. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use thru bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where thru bolts are used on hollow door and frame construction, provide sleeves for each thru bolt.
 - b. Steel Machine or Wood Screws: For the following fire-rated applications:
 - a.) Mortise hinges to doors.
 - b.) Strike plates to frames.
 - c.) Closers to doors and frames.

- c. Steel Thru Bolts: For the following fire-rated applications unless door blocking is provided:
 - a.) Surface hinges to doors.
 - b.) Closers to doors and frames.
 - c.) Surface-mounted exit devices.
 - d.) Spacers or Sex Bolts: For thru bolting of hollow-metal doors.
 - e.) Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

- B. Hinges:
 - 1. Interior door hinges: steel, plated .134 minimum thickness except as noted. Provide heavy weight .180 minimum thickness on doors wider than 3'0. Exterior door hinges: heavy weight .180 minimum thickness. Hinge size 4-1/2 x 4-1/2 unless otherwise noted in this schedule.
 - 2. Provide quantities as follows unless otherwise noted in the schedule:
 - a. For doors up to 60 inches in height, provide 1 pair of hinges; for doors 60 inches to 90 inches in height, provide 1-1/2 pairs of hinges; for doors over 90 inches and up to 120 inches in height, provide 1 additional hinge for each 30 inches of height.
 - b. Provide 4 hinges where indicated regardless of door height.
 - 3. Manufacturers / Series: Hager
700
800
AB850
AB750
AB700

- C. Continuous Hinges:
 - 1. Heavy duty, geared aluminum.
 - 2. Thrust bearings spaced 2-9/16 inches on center.
 - 3. Provide bearing at top to prevent debris from being inserted in top channel.
 - 4. Provide UL listed at fire labeled openings.
 - 5. Modify hinge for EPT power transfer device where required.
 - 6. Manufacturer / Series:
Hager
780-224HD

D. Locks and Latches

1. Locks and latches: Heavy duty mortise type, in accord with ANSI / BHMA standard A-156.13 2002, Series 1000, Grade 1.
2. Manufacturers / Series: Schlage
L9000-03A
3. Provide knurled levers on doors leading to hazardous areas. Hazardous areas as defined by the Illinois Accessibility Code.
4. Provide disability turnpiece (ADA) on thumbturn functions.

E. Exit Devices:

1. Provide exit devices with features, functions and options as shown in the hardware sets.
2. Exit Devices: Of the push pad design with grooved interior mechanism case. Device shall incorporate a fluid dampener which decelerates the push pad on its return stroke eliminating most noise associated with the device operation. Provide glass bead kits to provide clearance for raised glass trim.
3. Lever trim shall incorporate a break away feature. When locked the rigid lever will break away when more than 35 pounds of torque is applied.
4. Manufacturers / Series: Von Duprin
99 Series

F. Power Transfers:

1. Provide device to transfer electrical power from the door frame to the door. Unit is completely concealed when the door is closed.
2. 2 wires
3. Manufacturer / Series:
Von Duprin
EPT2

G. Power Supplies, EL Locks:

1. 1 amp, 24VDC, regulated and filtered, NEMA enclosure.
2. Provide 900-FA fire alarm option board as required.
3. Provide optional key lock cover.
4. Provide with battery back-up kit.
5. Manufacturer / Series:
Von Duprin
PS914

H. Electric Strikes:

1. Conform to requirements of ANSI A156.35, 2001 Grade 1.
2. Voltage 24VDC
3. Provide Fail Secure-FSE unless otherwise noted in the hardware sets.
4. Provide Dual Switches-DS unless otherwise noted in the hardware sets.
5. Manufacturer / Series:
Von Duprin
6211

I. Closers:

1. Provide door closers with features, functions and options shown in the hardware sets.
2. Materials and construction: High strength cast iron cylinder with full rack and pinion action. Spring power adjustable to 50%. Provide separate non-critical screw valves for regulation of latch speed, sweep speed, and back check. Hydraulic fluid type requiring no seasonal adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
3. Provide brackets, drop plates, spacer blocks, and accessories required to insure proper installation.
4. Parallel arms: Extra duty forged steel main arm, forearm and shoe.
5. Provide door closers on fire labeled openings.
6. Manufacturers /
Series: LCN
4040XP Series

J. Automatic Operators:

1. Automatic Operators: Low energy, slow opening type with a maximum opening force of 15 LBF to stop door swing.
2. Operator operates as conventional hydraulic door closer if it is deactivated by the fire alarm system or loss of power.
3. Electric motor / clutch assembly designed for quiet and smooth operation. The clutch provides a break away function to prevent damage to the operator if the door is forced closed during the powered opening swing.
4. Operator contains an on board, low voltage power supply providing 12 and 24 VDC output for actuators. Input and output power protected with replaceable slow blow fuses. Provide terminal strip for fire alarm input which would deactivate the unit.
5. Wall Plate Actuators: Hardwired low voltage actuator with round 4-1/2 inch diameter heavy stainless steel touch plate with engraved handicap symbol, blue filled.
6. Jamb Mounted Actuators: Hardwired low voltage actuate with rectangular stainless steel touch plate. 1-1/2 inch x 4-3/4 inch with engraved handicap symbol, blue filled.

7. Manufacturer / Series:
LCN
 4640
- K. Overhead Stops / Holders:
1. Satin stainless steel, ANSI / BHMA Grade 1.
 2. Manufacturer / Series:

	<u>GJ</u>
Heavy Duty, Concealed	100
Heavy Duty Surface	90
Medium Duty, Concealed	410
Medium Duty, Surface	450
- L. Pulls: 1 inch diameter bar stock. 12 inch center to center. Fasteners concealed.
1. Manufacturer / Series:
Hager
 12L
- M. Push Pull Bars:
1. Push/Pull Bars: 1-inch diameter bar stock. Push bar CTC 6 inches less than door width. Top of pull and lock stile end of push bar to back concealed mounted, Pull 12 inches CTC.
 2. Manufacturers / Series: Hager
 160D
 160V
- N. Pull Plates:
1. Pull plates: 4 x 16 .050 stainless steel with radius corners. Grip one inch diameter solid bar stock 8 inch CTC.
 2. Cut for cylinder or turnpiece when required.
 3. Manufacturers / Series: Hager
 40R x 4G
- O. Push Plates:
1. Push plates: 10 inches wide x 20 inches high (except reduce width to one inch less than lock stile when required). Stainless steel .050 with radius corners.
 2. Cut for cylinders or turnpiece when required.

- P. Kick Plates & Armor Plates
1. .050 stainless steel 10 inches high (Armor plates 36 inches high) x 2 inches less than door width on singles and 1 inch less on pairs. Fasteners full threaded, countersunk, undercut, stainless steel, sheet metal screws
- Q. Stops, Flush Bolts, Dust Proof Strikes:
1. Manufacturers / Series: Hager
234W
230W
283D
243F
282D
280X
292D
294D
- R. Thresholds:
1. Extra heavy extruded aluminum .25 thick. ½ x 5 inch with extra support leg.
 2. Provide with skid resistant abrasive nickel-aluminum composite finish.
 3. Provide with stainless steel machine screws and machine screw lead anchors.
 4. Manufacturer / Series:
National
425HD-SIA
- S. Door Bottoms, Weatherstripping and Smoke Seal:
1. Manufacturer / Series:
National
Sill 601A
Perimeter 5050B
Meeting Stiles 5070B
- T. Key Box:
1. Provide 6 inch x 6 inch x 4 inch NEMA, Type 4X SS, surface mounted, Type 304 stainless steel enclosure box with 16 gauge hinged solid door, 14 gauge body, hasp lock on door, and weatherstripping around door and body.
 2. Basis of Design: Hoffman Enclosures Inc.

2.3 FINISHES:

	<u>US SYMBOL</u>	<u>ANSI SYMBOL</u>	<u>DESCRIPTION</u>
Continuous Hinges	US28	628	Clear Aluminum
Hinges, Exterior	US32D	630	Satin Stainless
Hinges, Interior	US26D	626	Satin Chrome
Exit Devices	US26D	626	Satin Chrome
Locks	US26D	626	Satin Chrome
Closers	AL	689	Alum. Powder Coat
O.H. Holders	US32D	630	Satin Stainless
Stops, Flush Bolts	US26D	626	Satin Chrome
Push, Pull, Kick Plates	US32D	630	Satin Stainless Steel

2.4 KEYS AND KEYING:

- A. Cylinders: Schlage full size interchangeable core type. Provide Schlage Primus 20-740 C234 level 8 1-bitted cores with two keys for each lock and cylinder. Keying shall be performed by owner.
- B. Provide 10 temporary brass cores during construction.

PART 3 – EXECUTION

3.1 EXAMINATION:

- A. Verify doors and frames are ready to receive work and dimensions are as indicated on shop drawings or as instructed by manufacturers.
- B. Verify power supply is available to electrically operated devices.
- C. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION:

- A. General:
 - 1. Install each hardware item in accordance with each manufacturer’s instructions and recommendations.
 - 2. Install no hardware until substrate finishes are complete.
 - 3. Wherever cutting and fitting is required to install hardware onto or into surfaces, which are later to be painted or otherwise finished, install each item completely then remove and stored during application of finishes; Reinstall upon completion of finishing operations.
 - 4. Set items level, plumb and true to line and location.
 - 5. Adjust and reinforce attachment substrate as necessary for a secure installation.
 - 6. Drill and countersink items not factory prepared for fasteners.
 - 7. Space fasteners and anchors per manufacturer’s instructions and in accordance with industry standards.

8. Do not install hardware on doors, which have been improperly prepared.
 9. Attach wall mounted hardware to concealed wall blocking. Do not install wall mounted hardware where wall blocking has not been installed and arrange for blocking to be installed before proceeding.
- B. Fire-Rated Openings:
1. In addition to previous requirements, conform to NFPA 80 and BOCA covering installations of fire door assemblies.
 2. Refer to instructions from door and frame manufacturer's regarding special hardware installation requirements, including function holes, undercutting and minimum clearances between hardware cutouts.
- C. Installation Templates, Instruction Sheets and Schedules: Retain copies of templates, instruction sheets, schedules, installation details and similar data regarding hardware, maintenance and servicing. See Part 1 under Contract Closeout Submittals for assembly and distribution of data.
- D. Mounting Heights: Heights given are centerline heights up from finish floor unless stated otherwise: Heights given "Number to Number" indicate one height within limits given. Where heights of items are not listed, install in accordance with recommendations of DHI.
- | | | |
|----|--------------------|----------------------------------|
| 1. | Bottom Hinge | 10 to 13 inches from floor |
| 2. | Top Hinge | 7-1/2 to 11-3/4 inches from head |
| 3. | Intermediate Hinge | Equally spaced |
| 4. | Lock Lever | 38 to 40-5/16 inches |
| 5. | Deadlocks | 46 to 48 inches |
| 6. | Push Bar | 46 to 48 inches |
| 7. | Push Plate | 45 inches |
| 8. | Pull | 42 inches |
- E. Installation Requirements: In addition to mounting heights specified above, install hardware as follows:
1. Hinges:
 - a. Hang doors within following tolerances: 1/8" maximum between door and frame, and 1/8" maximum between meeting edges of pairs of doors.
 - b. Provide under door clearance at fire assemblies per NFPA 80.
 - c. Where shimming is necessary for proper door / frame installation, use only metal shims.
 - d. Install electric hinges or pivots as center hinge or second hinge from bottom where doors have 2 pairs of hinges.
 2. Locks: Install only curved lip strikes and dust box behind each strike.

3. Exit Devices:
 - a. Center exit device cases on door stiles, and equally spaced from each door edge, unless required otherwise by manufacturer's templates or instructions.
 - b. Locate power transfers in door and frame centered on exit devices.
4. Closers:
 - a. Install closers to permit maximum degree of door swing allowed by job conditions. Follow manufacturer's instructions.
5. Door Stops:
 - a. Install stops to permit maximum degree of door swing allowed by job conditions.
 - b. Locate floor stops so as not to create a tripping hazard, and to catch door at a point 6 inches in from latch edge, but in no case further than 1/3 door width measured from latch edge.
 - c. Wall stops intended for knobs and levers are to be located centered on spindle.
6. Protection plates: (Armor, Kick and Mop Plates)
 - a. Armor and kick plates: Install on push side of single acting doors.
 - b. Unless otherwise indicated install 1/4 inch up from door bottom.
7. Threshold:
 - a. Scribe and cut to fit profiles of door jambs with mitered corners and precision made joints.
 - b. Join units with concealed welds or concealed mechanical devices.
 - c. Cut smooth openings for mullions, bolts and similar items.
 - d. At exterior doors and elsewhere as indicated, set thresholds in bed of butyl rubber sealant, completely fill voids to exclude moisture.
 - e. At exterior doors, install bevel of threshold aligned with exterior face of door, unless indicated otherwise by detail or threshold manufacturer's instructions.
 - f. Install thresholds level.
 - g. Do not install thresholds over carpet. At fire rated doors do not install the thresholds over any finish material, unless material is noncombustible, e.g. ceramic tile, terrazzo or concrete.

8. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.
 - a. Configuration: Provide the least number of power supplies required to adequately serve doors with electrified door hardware.

F. Miscellaneous Hardware:

1. Push / Pull Sets: Center push / pull sets on doors stiles unless noted otherwise on plans. Mount push bar centered 42 inches above finished floor.

G. Doors with Electric Hardware:

1. Doors with Card Reader, Electric Strikes or Electric Locks:
 - a. Wire card reader or keypad to operate electric strike or lock.
 - b. Electric locks are fail secure and lock when power off.

3.3 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service:

1. Closer: After air handling system has been balanced arrange for closer to be finally adjusted by person trained by closer manufacturer or closer manufacturer's representative.
 - a. Adjust closer to take 3 seconds minimum for door to swing from a 70 degree position to 3" from latching position.
 - b. Adjust closer not to exceed 5 lbs. opening force.
Exception: Fire doors as required to close & latch.

3.4 ADJUSTING:

A. Adjusting & Cleaning:

1. Adjust and check each item of hardware and each door to insure proper operation and function of each unit.
2. Lubricate moving parts with graphite-type lubricant unless otherwise recommended by manufacturer.
3. Replace hardware, which cannot be lubricated and adjusted to operate freely and smoothly

4. Final Adjustment:

- a. Whenever hardware installation is made more than 1 month prior to acceptance of work, make final adjustment and check of hardware during week immediately prior to acceptance, unless otherwise directed by Architect.
- b. Clean and re-lubricate operation items as necessary to restore proper functioning and finish of hardware and doors.
- c. Make final adjustment of locksets and closers to compensate for operation of heating and ventilating systems under supervision of manufacturer's representative.

3.5 PROTECTION AND CLEANING:

A. Installed Hardware: Protect door hardware against damage.

B. Installed Doors:

1. Do not prop doors open using any item wedged between hinge jamb and door.
2. Use only rubber stops, cardboard or rope.
3. Do not use unprotected wood wedges under wood doors.
4. Do not use bare wire or other unprotected means of securing doors in open position which may mar door or hardware.

C. Job Acceptance: Prior to acceptance of job, clean hardware surfaces on both interior and exterior doors of mortar, plaster, paint caulking and other contaminants. Replace hardware damaged after installation where finish cannot be restored after cleaning.

3.6 HARDWARE SCHEDULE:

A. Hardware set numbers have prefixes to identify the general function of the hardware. Prefix definitions:

1. EAC: Electrified Access Control
2. BAC: Battery Access Control
3. E: Electrified Hardware
4. H: Mechanical Hardware

B. Abbreviations used in the Hardware

Sets: Auto: Automatic
BE: Blank Escutcheon, No Cylinder
CD: Cylinder Dogging
CUSH: Positive Stop Closer Arm
DA: Delayed Action
EL: Electrified
EM: Electro-Mechanical

EO:	Exit Only
F:	Fire Labeled
H:	Hold-Open
L:	Lever Trim
LBR:	Less Bottom Rod
LX:	Latchbolt Monitor Switch
NRP:	Non Removable Pin
O.H.:	Overhead Holder
SE:	Single Point Electrical Hold Open

C. HARDWARE SETS TO BE ADDED.

END SECTION 08 71 00

SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This 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. Doors.
 - 2. Glazed entrances and storefronts.
 - 3. Glazed curtainwall.
 - 4. Interior sidelights and borrowed lights.
- B. Related Sections include the following:
 - 1. Section 08 11 13 "Hollow Metal Doors and Frames."
 - 2. Section 08 14 16 "Flush Wood Doors."
 - 3. Section 08 41 13 "Aluminum-Framed Entrances and Storefronts."
 - 4. Section 08 44 13 "Glazed Aluminum Curtain Walls."
 - 5. Section 08 83 00 "Mirrors."

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. Interspace: Space between lites of an insulating-glass unit.
- D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

- E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
- F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
- C. Glazing Accessory Samples:
 - 1. Glazing gaskets
 - 2. Sealants
- D. Warranties: Special warranties specified in this Section.
- E. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- F. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- G. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
 - 1. For solar-control, low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.
- H. Qualification Data: For installers.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Source Limitations for Glass Sputter-Coated with Solar-Control Low-E Coatings: Where solar-control low-e coatings of a primary glass manufacturer that has established a certified fabricator program is specified, obtain sputter-coated solar-control low-e-coated glass in fabricated units from a manufacturer that is certified by coated-glass manufacturer.
- C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

- D. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201.
 - 1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
- E. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.
 - 1. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C).

1.8 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: 5 years from date of manufacture.
- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: 10 years from date of manufacture.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements.
 2. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product indicated.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
 1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 - a. Specified Design Wind Loads: As indicated, but not less than wind loads applicable to Project as required by ASCE 7 "Minimum Design Loads for Buildings and Other Structures": Section 6.0 "Wind Loads."
 - b. Specified Snow Loads: As indicated on Drawings.
 - c. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, provide glass thickness to resist design wind pressure based on glass type factors for short-duration load.
 - d. Thickness of Patterned Glass: Base glass thickness of patterned glass on thickness at thinnest part of the glass.
 - e. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, provide glass thickness for a probability of breakage not greater than 0.001.
 - f. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide glass thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch (25 mm), whichever is less.
 - 1) For insulating glass.
 - g. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
 - h. Differential Shading: Provide glass thickness to resist thermal stresses induced by differential shading within individual glass lites.

- C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- D. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
 - 1. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - 2. For laminated-glass lites, properties are based on products of construction indicated.
 - 3. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:
 - a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F (W/sq. m x K).
 - b. Solar Heat Gain Coefficient: NFRC 200.
 - c. Solar Optical Properties: NFRC 300.

2.3 GLASS PRODUCTS

- A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
 - 2. For uncoated glass, comply with requirements for Condition A.
 - 3. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
 - 4. Provide Kind FT (fully tempered) float glass where safety glass is indicated or required by code.
- C. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Type II, Class 1 (clear), with safety glazing label.
- D. Ceramic-coated Spandrel Glass: ASTM C 1048, Condition B (spandrel glass, one surface ceramic coated), Type I (transparent flat glass), Quality-Q3, and complying with other requirements specified.

2.4 LAMINATED GLASS

- A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with ionomeric polymer interlayer, or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

2.5 INSULATING GLASS

- A. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.
1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
 2. Provide Kind FT (fully tempered) glass lites where safety glass is indicated or required by code.
 3. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal, and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
 4. Sealing System: Dual seal, with primary and secondary sealants as follows:
 - a. Manufacturer's standard sealants.
 5. Spacer Specifications: Manufacturer's standard spacer material and construction.

2.6 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:
1. Silicone, ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
1. Silicone.

2.7 GLAZING SEALANTS

- A. General: Provide products of type indicated and as recommended by the manufacturer.
- B. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less.
- C. Glazing Sealants for Fire-resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Aluminum Shoe: 6063 aluminum, mill finish, for 1/2 inch glass, with setting blocks. Size: 2- 3/4 inches tall, 1-3/8 inches wide, 1-15/16 inch deep throat.

2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

2.10 MONOLITHIC-GLASS UNITS

- A. Glass Type GL-4: Clear annealed float glass.
 - 1. Thickness: 6.0 mm.
- B. Glass Type GL-5: Acid-etched, clear, fully tempered float glass with decorative glass paint or ink applied to glass surface and cured.
 - 1. Thickness: 6.0 mm.
 - 2. Acid-Etched Finish: Acid etching the glass evenly on second surface.
 - 3. Decorative Glass Paint: Logo image from Owner on first surface. Color: As selected by Architect from manufacturer's full range.
 - 4. Provide safety glazing labeling.

2.11 LAMINATED-GLASS TYPES

- A. Glass Type GL-6: Laminated clear float glass.
 - 1. Thickness of Each Glass Ply: 6.0 mm.
 - 2. Interlayer Thickness: 0.030 inch (0.76 mm).

3. Provide safety glazing labeling.
- B. Glass Type GL-6T: Laminated clear, fully tempered float glass.
1. Thickness of Each Glass Ply: 6.0 mm.
 2. Interlayer Thickness: 0.030 inch (0.76 mm).
 3. Provide safety glazing labeling.
- C. Glass Type GL-7: Laminated clear, fully tempered frosted float glass.
1. Thickness of Each Glass Ply: 6.0 mm.
 2. Interlayer Thickness: 0.030 inch (0.76 mm).
 3. Coating: Frosted on Surface 2 with UIS Logo. Graphics provided by Owner.
 4. Provide safety glazing labeling.

2.12 INSULATING-GLASS UNITS

- A. Glass Type GL-1: Low-e-coated, clear insulating glass.
1. Overall Unit Thickness: 1 inch (25 mm).
 2. Thickness of Each Glass Lite: 6.0 mm.
 3. Outdoor Lite: Annealed float glass.
 4. Interspace Content: Argon.
 5. Indoor Lite: Annealed float glass.
 6. Low-E Coating: Sputtered on second surface.
 7. Visible Light Transmittance: 64 percent minimum.
 8. Winter Nighttime U-Factor: 0.24 maximum.
 9. Summer Daytime U-Factor: 0.21 maximum.
 10. Solar Heat Gain Coefficient: 0.27 maximum.
 11. Basis of Design: PPG "Solarban 70XL (2)" on Starphire or one of these comparable products:
 - a. Viracon VNE1-63 on Starphire.
 - b. Guardian Superneutral 54 (#2) on Ultrawhite.
- B. Glass Type GL-1T: Low-e-coated, clear insulating tempered glass.
1. Overall Unit Thickness: 1 inch (25 mm).
 2. Thickness of Each Glass Lite: 6.0 mm.
 3. Outdoor Lite: Fully tempered float glass.
 4. Interspace Content: Argon.
 5. Indoor Lite: Fully tempered float glass.
 6. Low-E Coating: Sputtered on second surface.
 7. Visible Light Transmittance: 64 percent minimum.
 8. Winter Nighttime U-Factor: 0.24 maximum.
 9. Summer Daytime U-Factor: 0.21 maximum.
 10. Solar Heat Gain Coefficient: 0.27 maximum.
 11. Basis of Design: PPG "Solarban 70XL (2)" on Starphire or one of these comparable products:
 - a. Viracon VNE1-63 on Starphire.
 - b. Guardian Superneutral 54 (#2) on Ultrawhite.

C. Glass Type GL-2: Low-e-coated, clear insulating glass.

1. Overall Unit Thickness: 1 inch (25 mm).
2. Thickness of Each Glass Lite: 6.0 mm.
3. Outdoor Lite: Annealed float glass.
4. Interspace Content: Argon.
5. Indoor Lite: Annealed float glass.
6. Low-E Coating: Sputtered on second surface.
7. Visible Light Transmittance: 70 percent minimum.
8. Winter Nighttime U-Factor: 0.24 maximum.
9. Summer Daytime U-Factor: 0.22 maximum.
10. Solar Heat Gain Coefficient: 0.39 maximum.
11. Basis of Design: PPG "Solarban 60" or one of these comparable products:
 - a. Viracon VNE13-63.
 - b. Guardian Superneutral 68 (#2) on clear.

D. Glass Type GL-2T: Low-e-coated, clear insulating tempered glass.

1. Overall Unit Thickness: 1 inch (25 mm).
2. Thickness of Each Glass Lite: 6.0 mm.
3. Outdoor Lite: Fully tempered float glass.
4. Interspace Content: Argon.
5. Indoor Lite: Fully tempered float glass.
6. Low-E Coating: Sputtered on second surface.
7. Visible Light Transmittance: 70 percent minimum.
8. Winter Nighttime U-Factor: 0.24 maximum.
9. Summer Daytime U-Factor: 0.22 maximum.
10. Solar Heat Gain Coefficient: 0.39 maximum.
11. Basis of Design: PPG "Solarban 60" or one of these comparable products:
 - a. Viracon VNE13-63.
 - b. Guardian Superneutral 68 (#2) on clear.

E. Glass Type GL-3: Ceramic-coated, insulating spandrel glass.

1. Overall Unit Thickness: 1 inch (25 mm).
2. Thickness of Each Glass Lite: 6.0 mm.
3. Outdoor Lite: Heat-strengthened clear float glass. Basis of Design: PPG Starphire or one of these comparable products:
 - a. Viracon VNE-63 (#2).
 - b. Guardian Superneutral 54 (#2).
4. Interspace Content: Argon.
5. Indoor Lite: Heat-strengthened clear float glass.
6. Low-E Coating: Sputtered on second surface.
7. Spandrel Coating: Basis of Design: PPG Medium Gray 3-0586 Ceramic Frit on fourth surface or one of these comparable products:
 - a. Viracon Fog Grey V1087.

8. Winter Nighttime U-Factor: 0.24 maximum.
9. Summer Daytime U-Factor: 0.21 maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing glazing, 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 system.
 3. Minimum required face or 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 glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

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. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- 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. 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.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glasslites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm) as follows:
 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 (3-mm) 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.

- G. 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.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- J. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

- A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Install gaskets so they protrude past face of glazing stops.

3.5 CLEANING AND PROTECTION

- A. Protect 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, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended 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 08 80 00

SECTION 08 83 00 - MIRRORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following types of silvered flat glass mirrors:
 - 1. Film-backed glass mirrors qualifying as safety glazing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
- B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.
- C. Sample Warranty: For special warranty.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
- C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.
- D. Glazing Publications: Comply with the following published recommendations:
 - 1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
 - 2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
- E. Safety Glazing Products: For film-backed mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

- F. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing and substrates on which mirrors are installed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SILVERED FLAT GLASS MIRRORS

- A. Glass Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.
- B. Clear Glass: Mirror Select Quality.
 - 1. Nominal Thickness: 6.0 mm.

2.2 MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.

1. Adhesives shall have a VOC content of 70 g/L or less.
- D. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.3 MIRROR HARDWARE

- A. Top and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
1. Bottom Trim: J-channels formed with front leg and back leg not less than $\frac{3}{8}$ and $\frac{7}{8}$ inch (9.5 and 22 mm) in height, respectively, and a thickness of not less than 0.05 inch (1.3 mm).
 2. Top Trim: J-channels formed with front leg and back leg not less than $\frac{5}{8}$ and 1 inch (16 and 25 mm) in height, respectively, and a thickness of not less than 0.062 inch (1.57 mm).
 3. Finish: Clear bright anodized.
- B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
- C. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.4 FABRICATION

- A. Mirror Edge Treatment: Rounded polished (Pencil).
1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
 2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.
- B. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- B. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.

- C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
- B. Provide a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- C. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 - 1. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long at bottom channel.
 - 2. Install mastic as follows:
 - a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
 - b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
 - c. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface.

3.4 CLEANING AND PROTECTION

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
- B. Do not permit edges of mirrors to be exposed to standing water.
- C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
- D. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 08 83 00

SECTION 08 91 19 - FIXED LOUVERS

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. Fixed, extruded-aluminum louvers.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).
- C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- D. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.
- D. Delegated-Design Submittal: For louvers indicated to comply with structural and seismic performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.
- B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq. ft. (1436 Pa), acting inward or outward.
- C. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- D. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- F. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal, Continuous-Line, Drainable-Blade Louver: Drainable-blade louver with blade gutters (drains) in rear two-thirds of blades only and with semirecessed mullions capable of collecting and draining water from blades.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrow United Industries; a division of Mestek, Inc.
 - b. Construction Specialties, Inc.
 - c. Greenheck Fan Corporation.
 - d. Pottorff.
 - e. Ruskin Company; Tomkins PLC.
 2. Louver Depth: Coordinate with curtainwall frame.
 3. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm).
 4. Louver Performance Ratings:
 - a. Free Area: Not less than 7.8 sq. ft. (0.72 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
 - b. Point of Beginning Water Penetration: Not less than 850 fpm (4.3 m/s).
 - c. Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 800-fpm (4.1-m/s) free-area exhaust velocity.

2.4 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
1. Screen Location for Fixed Louvers: Interior face.
 2. Screening Type: Insect screening.
- B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches (150 mm) from each corner and at 12 inches (300 mm) o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
 2. Finish: Same finish as louver frames to which louver screens are attached.
 3. Type: Rewirable frames with a driven spline or insert.
- D. Louver Screening for Aluminum Louvers:
1. Insect Screening: Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm) wire.

2.5 BLANK-OFF PANELS (IF SHOWN)

- A. Insulated, Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.
 - 1. Thickness: 1 inch (25 mm).
 - 2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch (0.81-mm) nominal thickness.
 - 3. Insulating Core: Rigid, glass-fiber-board insulation or extruded-polystyrene foam.
 - 4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch (2.03-mm) nominal thickness, with corners mitered and with same finish as panels.
 - 5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
 - 6. Panel Finish: Same finish applied to louvers.
 - 7. Attach blank-off panels with sheet metal screws.

2.6 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 - 2. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.7 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 - 1. Frame Type: Channel unless otherwise indicated.
- D. Include supports, anchorages, and accessories required for complete assembly.
- E. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.

1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.

F. Provide subsills made of same material as louvers for recessed louvers.

G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.8 ALUMINUM FINISHES

A. Class I, Clear Anodic Finish, unless otherwise shown: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 91 19

SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.
- B. Related Sections include the following:
 - 1. Section 09 22 16 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board.
 - 2. Division 09 painting Sections for primers applied to gypsum board surfaces.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PANELS, GENERAL

- A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Georgia-Pacific Gypsum LLC.
 - b. National Gypsum Company.
 - c. USG Corporation.

- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

- 1. Thickness: 5/8 inch (15.9 mm).
- 2. Long Edges: Tapered.

- C. Gypsum Ceiling Board: ASTM C 1396/C 1396M.

- 1. Thickness: 5/8 inch (15.9 mm).
- 2. Long Edges: Tapered.

2.3 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.

- 1. Products: Subject to compliance with requirements, provide one of the following:

- a. C-Cure; 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 (15.9 mm) thick.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.

- 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, or plastic.

- a. Shapes:
 - 1) Cornerbead.
 - 2) LC-Bead: J-shaped; exposed long flange receives joint compound.
 - 3) L-Bead: L-shaped; exposed long flange receives joint compound.
 - 4) Expansion (control) joint.
 - 5) Other miscellaneous beads and trim as indicated or required.

2. Material: Aluminum.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Fry Reglet Corporation.
 - 2) Gordon, Inc.
 - 3) Pittcon Industries.
- b. Shape and Size: As indicated.
 - 1) Basis-of-Design Aluminum L Trim: Fry Reglet; DRML in size indicated.
 - 2) Basis-of-Design Corner Trim: Fry Reglet; DMCT-375.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Wallboard: Paper.
 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 2. Fill Coat: For second coat, use drying-type, all-purpose compound.
 3. Finish Coat: For third coat, use drying-type, all-purpose compound.
 4. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum

panels to continuous substrate.

1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
1. Verify that sound attenuation blankets are installed prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.

2. Fit gypsum panels around ducts, pipes, and conduits.
 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
1. Type X: Vertical surfaces, unless otherwise indicated.
 2. Ceiling Type: Ceiling surfaces.
- B. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
1. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 2. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. LC-Bead: Use at exposed panel edges.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels that are substrate for tile.
 - 3. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
 - 4. Level 5: 1/8" skim coat plaster on gypsum board - Where indicated on Drawings.

3.7 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00

SECTION 09 30 13 - TILING

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. Porcelain tile.
2. Quarry tile.
3. Glass tile.
4. Natural stone strip tile.
5. Waterproof membrane for thinset applications.
6. Crack isolation membrane.
7. Metal edge strips.

B. Related Requirements:

1. Section 07 92 00 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
2. Section 09 29 00 "Gypsum Board" for cementitious backer units.

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 A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "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 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.
- D. Samples for Verification:
 - 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Full-size units of each type of trim and accessory for each color and finish required.
 - 3. Metal edge strips in 6-inch (150-mm) lengths.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of each type of floor tile installation.
 - 2. Build mockup of each type of wall tile installation.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. 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.

1.9 FIELD 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each color or finish from single 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 single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - 1. Waterproof membrane.
 - 2. Crack isolation membrane.
 - 3. Metal edge strips.

2.2 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.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- 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.

2.3 TILE PRODUCTS, GENERAL

- A. Tile has been selected for both its aesthetic and performance characteristics. Any proposed substitution of this product must meet or exceed the characteristics of the indicated product in both appearance and all aspects of product performance.
- B. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - 1. Base Cap: Surface bullnose, module size.
 - 2. Wainscot Cap: Surface bullnose, module size.

2.4 TILE (TL)

- A. Products: See Finish Legend.

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. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Custom Building Products; FractureFree Crack Prevention Membrane.
 - b. Laticrete International, Inc; Laticrete Hydro Ban.
 - c. MAPEI Corporation; Mapelastic™ CI.

2.6 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thinset): ANSI A118.11.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C-Cure.
 - b. Custom Building Products.
 - c. Laticrete International, Inc.
 - d. MAPEI Corporation.
 - e. TEC; H.B. Fuller Construction Products Inc.
 - 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. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
 - 4. For wall applications, provide mortar that complies with requirements for nonsagging

mortar in addition to the other requirements in ANSI A118.11.

- B. Medium-Bed, Latex-Portland Cement Mortar: Comply with requirements in ANSI A118.11. Provide product that is approved by manufacturer for application thickness of 5/8 inch (16mm).
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C-Cure.
 - b. Custom Building Products.
 - c. Laticrete International, Inc.
 - d. MAPEI Corporation.
 - e. TEC; H.B. Fuller Construction Products Inc.
 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. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
- C. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Custom Building Products.
 - b. Laticrete International, Inc.
 - c. MAPEI Corporation.
 - d. TEC; a subsidiary of H. B. Fuller Company.
 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.

2.7 GROUT MATERIALS

- A. Polymer-Modified Tile Grout: ANSI A118.7.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Custom Building Products.
 - b. Laticrete International, Inc.
 - c. MAPEI Corporation.
 2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, re-dispersible form, prepackaged with other dry ingredients, or polymer Type: Acrylic resin in liquid-latex form for addition to prepackaged dry-grout mix.
- B. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Custom Building Products.
 - b. Laticrete International, Inc.
 - c. MAPEI Corporation.
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. Metal Edge Strips: Angle or L-shaped, and other shapes indicated in height to match tile and setting-bed thickness (unless otherwise indicated), metallic, designed specifically for tiling applications; aluminum or stainless-steel, ASTM A 666, 300 Series exposed-edge material.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Schluter Systems L.P.
 - b. Blanke Corporation.
 - c. Ceramic Tool Company.
 2. Refer to drawing for indicated applications and other requirements including, but not limited to, the following:
 - a. Floor Transition: Basis-of-Design: Schluter; SCHIENE.
- C. 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.
- D. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Custom Building Products; Grout Sealer.
 - b. MAPEI Corporation; KER 003, Silicone Spray Sealer for Cementitious Tile Grout.
 - c. Southern Grouts & Mortars, Inc.; Silicone Grout Sealer.
 - d. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thinset 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.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (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.

3.3 TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors consisting of tiles 8 by 8 inches (200 by 200 mm) or larger.
 - b. Tile floors consisting of rib-backed tiles.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - 2. 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.
 - 3. Lay tile in pattern indicate in Finish List on Drawings.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Glazed Wall Tile: 1/16 inch (1.6 mm).
 - 2. Porcelain Tile: 1/8 inch (3.2 mm).
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, align tile pattern to locate joints in tile surfaces directly above them and maintain full tiles; where that is not possible, locate expansion joints at nearest tile joint maintaining full tiles.
- J. Metal Edge Strips: Install at locations indicated and where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

- K. Grout Sealer: Apply grout sealer to grout joints 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 that is bonded securely to substrate.
- B. Allow waterproofing to cure and verify by testing that it is watertight before installing tile or setting materials over it.

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 that is bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.6 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. 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.

3.7 PROTECTION

- A. 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.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 09 30 13

SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

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 acoustical panels and exposed suspension systems for ceilings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Product Data: For sealants, indicating VOC content.
- C. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.
- D. Certification: Provide Certification signed by Manufacturer of acoustical ceiling panels that the panels are suitable for use with a plenum return ceiling, and that panels will not allow return air to pass through them.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes 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. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in anyway.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.
- B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- C. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 40 percent.
- D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.
- E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL PANELS ACT-1

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong Ceilings; Optima Square Tegular 3251 with Suprafine 9/16" Exposed Tee Grid or an equal product by one of the following:
 - 1. Rockfon; Sonar 16200.
 - 2. USG Interiors, Inc.; Halcyon ClimaPlus 98225.
- B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form 2, cloth. Binder shall not contain urea formaldehyde.
 - 2. Patterns: E (lightly textured).
- C. Color: White.
- D. LR: Not less than 0.90.
- E. NRC: Not less than 0.95.
- F. AC: Not less than 190.
- G. Edge/Joint Detail: Square tegular.
- H. Thickness: 1inch (25 mm).
- I. Modular Size: 24 by 24 inches (610 by 610 mm).

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
 - 1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- (3.5-mm-) diameter wire.
- D. Stabilizer Clips: Manufacturer's standard stabilizer clips designed and spaced to secure acoustical panels in place.

2.5 METAL SUSPENSION SYSTEM

- A. Narrow-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 (Z90) coating designation; with prefinished 9/16-inch- (15-mm-) wide metal caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. Face Design: Flat, flush.
 - 3. Face Finish: White, except Black for ACT-2.

2.6 ACOUSTICAL SEALANT

- A. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
 - 2. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 METAL EDGE MOLDINGS AND TRIM

- A. 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 lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 - 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- B. Accessories: "Teg Tab" polymer block designed to clip on to grid and alleviate the need to trim panels at perimeter edges. Choose Teg Tab according to grid face width.
- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying

with seismic design requirements and the following:

1. Basis of Design: Armstrong World Industries, "Axiom Classic Trim" or comparable product by:
 - a. Hunter Douglas; Channel Trim System.
2. Profile: 2 inch and 2-7/8 inch straight. See Drawings for locations.
3. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.
4. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - a. Colors: Black and White. See Drawings for locations.

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

- 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, furnish and install, as work of this section, 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 or to supplemental framing provided as work of this section.
 8. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) 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. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. 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 (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 CLEANING

- A. Clean 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 09 51 13

SECTION 09 54 26 - LINEAR WOOD CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes wood ceiling panels and suspension systems for ceilings.
- B. Related Sections:
 - 1. Section 09 51 13 "Acoustical Panel Ceilings" for ceilings consisting of mineral-base and glass-fiber-base acoustical panels and exposed suspension systems.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For components with factory-applied color and other decorative finishes.
- C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:
 - 1. Wood panel: Set of 12-inch- (300-mm-) long Samples of each type and color and a 12-inch- (300-mm-) long spliced section.
 - 2. Suspension System Members: 12-inch- (300-mm-) long Sample of each type.
 - 3. Exposed Molding and Trim: Set of 12-inch- (300-mm-) long Samples of each type, finish, and color.
 - 4. Filler Strips: Set of 12-inch- (300-mm-) long Samples of each type, finish, and color.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Panel pattern.
 - 2. Joint pattern.
 - 3. Ceiling suspension members.
 - 4. Method of attaching hangers to building structure.
 - 5. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
 - 6. Ceiling perimeter and penetrations through ceiling; trim and moldings.
 - 7. Minimum Drawing Scale: 1/4 inch = 1 foot (1:48).
- B. Qualification Data: For testing agency.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each linear metal ceiling.

- D. Evaluation Reports: For linear metal ceiling and components and anchortype.
- E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes 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. Wood Ceiling Components: Quantity of each panel, carrier, accessory, and exposed molding and trim equal to 2 percent of quantity installed.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each set of linear wood panels and suspension systems from one source with resources to provide products of consistent quality in appearance, physical properties, and performance.
- B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- D. Surface-Burning Characteristics: Complying with ASTM E 1264 for Class A materials, as determined by testing identical products according to ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver linear wood panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Handle linear wood panels, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install linear wood ceilings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.9 COORDINATION

- A. Coordinate layout and installation of linear wood panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Certified Wood: Wood products shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-00 and FSC STD-40-004.
- B. Composite Wood Products: Products shall be made without urea formaldehyde.

2.2 WOOD CEILING WD-2

- A. Linear Wood Panel System: Provide manufacturer's standard linear wood panel system of configuration indicated.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc.; Woodworks Linear 6640W1-NLC or a comparable product by one of the following:
 - a. Hunter Douglas Architectural Products, Inc.; Linear Wood Open.
 - b. Rulon Company; Linear Open Style.
- B. Wood Panel Fabrication: Manufacturer's standard units of size and profile indicated, formed from wood indicated to snap on and be securely retained on metal carriers without separate fasteners, and finished to comply with requirements indicated.
- C. Panel: Perforated prime grade, all-natural Light Cherry (NLC) color veneer over fire retardant medium density fiberboard.
- D. NRC: Not less than 0.50.
- E. Thickness: 3/4 inch (19 mm).
- F. Modular Size: 4.5 inches by 96 inches.
- G. Moldings and Trim: Provide manufacturer's standard moldings and trim for exposed members, and as indicated or required, for edges and penetrations of ceiling, around fixtures, at changes in ceiling height, and for other conditions; of same metal and finish as linear wood ceiling panels, unless indicated otherwise.

- H. Sound-Absorbent Fabric Layer: Provide factory attached fabric layer, sized to fit concealed surface of panel, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
 - 1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- (3.5-mm-) diameter wire.
- E. Stabilizer Clips: Manufacturer's standard stabilizer clips designed and spaced to secure acoustical panels in place.
- F. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers at regular intervals and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated; and factory finished with matte-black baked finish.
- G. Edge Moldings and Trim: Provide exposed members as indicated or required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of penetrations through ceiling, to conceal ends of panels and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear wood panels or extruded plastic unless otherwise indicated.
 - 1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which linear metal 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 linear metal ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of linear wood panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width or -length panels at borders, and comply with layout shown on reflected ceiling plans and Coordination Drawings.

3.3 INSTALLATION

- A. 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 to which hangers are attached and for type of hanger involved.
 - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age,

- corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. 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.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- B. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers but without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- C. Install edge moldings and trim of type indicated at perimeter of linear wood ceiling area and where necessary to conceal edges and ends of linear wood panels.
1. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension system carriers so they are aligned and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. Cut linear wood panels for accurate fit at borders and at interruptions and penetrations by other work through ceilings.
- F. Install wood panels in coordination with suspension system and exposed moldings and trim.
1. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.
 2. Install panels with butt joints in the following joint configuration:
 - a. Staggered randomly a minimum of 12 inches (300 mm).
 3. Install wood panels in directions indicated.
- 3.4 CLEANING
- A. Clean exposed surfaces of wood ceilings, including trim and edge moldings after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, 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, including dented and bent units.

END OF SECTION 09 54 26

SECTION 09 65 13 - RESILIENT BASE 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. Vinyl base.
 - 2. Rubber stair accessories.
 - 3. Rubber molding accessory.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches (300 mm) long.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches (300 mm) long.
- E. Product Schedule: For resilient base and accessory products.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following periods:
 1. 48 hours before installation.
 2. During installation.
 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 VINYL BASE

- A. Product Standard: Johnsonite Silver Gary #55, cove base or equal approved by Architect in an addendum.
- B. Minimum Thickness: 0.125 inch (3.2 mm).
- C. Height: 4 inches (102 mm).
- D. Lengths: Coils in manufacturer's standard length.
- E. Outside Corners: Job formed or preformed.
- F. Inside Corners: Job formed or preformed.

2.2 RUBBER STAIR ACCESSORIES

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. Stair Treads: ASTM F2169.
1. Type: TS (rubber, vulcanized thermoset).
 2. Class: 2 (pattern; embossed, grooved, or ribbed).
 3. Group: 2 (with contrasting color for the visually impaired).
 4. Nosing Style: Square, adjustable to cover angles between 60 and 90 degree.
 5. Nosing Height: 2 inches (51 mm).
 6. Thickness: 1/4 inch (6 mm) and tapered to back edge.
 7. Size: Lengths and depths to fit each stair tread in ne piece.
 8. Integral Risers: Smooth, flat; in height that fully covers substrate.
- C. Stringers: Height and length after cutting to fit risers and treads and to cover stair stringers, produced by same manufacturer as treads, and recommended by manufacturer for installation with treads.
1. Thickness: 0.125 inch (3.2 mm).
- D. Locations: Provide rubber stair accessories for all stairs.
- E. Colors and Patterns: Match Architect's sample.

2.3 RUBBER MOLDING ACCESSORY

- A. Description: Rubber cap for cove carpet, cap for cove resilient floor covering, nosing for resilient floor covering, reducer strip for resilient floor covering, joiner for tile and carpet, and transition strips.
- B. Profile and Dimensions: As indicated.
- C. Locations: Provide rubber molding accessories in areas indicated.
- D. Colors and Patterns: Match Architect's sample.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
- C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.
- D. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests 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. (1.36 kg of water/92.9 sq. m) 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. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
 - a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Stair Accessories:
 - 1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
 - 2. Tightly adhere to substrates throughout length of each piece.
 - 3. For treads installed as separate, equal-length units, install to produce a flush joint between units.
- C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from surfaces.
 2. Sweep and vacuum horizontal surfaces thoroughly.
 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor polish.
1. Apply three coats.
- E. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13

SECTION 09 65 19 - RESILIENT TILE FLOORING

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. Vinyl composition floor tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of resilient floor tile.
 - 1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 2. Show details of special patterns.
- C. Samples: Full-size units of each color, texture, and pattern of floor tile required.
- D. Samples for Initial Selection: For each type of floor tile indicated.
- E. Samples for Verification: Full-size units of each color and pattern of floor tile required.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - a. Size: Minimum 100 sq. ft. (9.3 sq. m) for each type, color, and pattern in locations directed by Architect.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store floor tiles on flat surfaces.

1.9 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 VINYL COMPOSITION FLOOR TILE

- A. Product: Non-slip style Armstrong Safety Zone series or equal approved by Architect in an addendum.
- B. Thickness: 0.125 inch (3.2 mm).
- C. Size: 12 by 12 inches (305 by 305 mm).
- D. Colors and Patterns: Match Architect's samples.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests 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. (1.36 kg of water/92.9 sq. m) 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. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles in pattern indicated.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles in pattern of colors and sizes indicated.

- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish, only use product recommended by manufacturer: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
 - 1. Apply three coats.
- E. Joint Sealant: Apply sealant to resilient terrazzo floor tile perimeter and around columns, at door frames, and at other joints and penetrations.
- F. Cover floor tile until Substantial Completion.

END OF SECTION 09 65 19

SECTION 09 65 43 - LINOLEUM FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Linoleum sheet floor coverings.

B. Related Sections include the following:

1. Division 09 Section "Resilient Base and Accessories" for resilient wall base, reducer strips, and other accessories installed with linoleum floor coverings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

C. Samples: For each exposed product and for each color and pattern specified in manufacturer's standard size, but not less than 6-by-9-inch (152-by-230-mm) sections.

1. Include similar Samples of installation accessories involving color selection.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For linoleum floor coverings to include in maintenance manuals.

1.4 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. Sheet Flooring: Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, in roll form and in full roll width for each type, color, and pattern of sheet flooring installed.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project that are competent in techniques required by manufacturer for floor covering installation indicated.

1. Engage an installer who employs workers for this Project that are trained or certified by floor covering manufacturer for installation techniques required.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 90 deg F (32 deg C).
 - 1. Sheet Floor Covering: Store rolls upright.

1.7 FIELD CONDITIONS

- A. Maintain temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following time periods:
 - 1. 72 hours before installation.
 - 2. During installation.
 - 3. 72 hours after installation.
- B. After installation and until Substantial Completion, maintain temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Close spaces to traffic during floor covering installation.
- D. Close spaces to traffic for 72 hours after floor covering installation.
- E. Install floor coverings after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For linoleum flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 LINOLEUM FLOOR COVERING

- A. Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Armstrong World Industries; Marmorette, Verify Color with Architect.
 - 2. Forbo; Marmoleum Real, Verify Color with Architect.
 - 3. Johnsonite; Veneto, Verify Color with Architect.
- B. Colors and Patterns: As indicated by manufacturer's designations on the Room Finish plans and schedules in the drawings.
- C. Sheet Floor Covering: ASTM F 2034.
 - 1. Roll Size: In manufacturer's standard length by not less than 78 inches (1980 mm) wide.
- D. Seaming Method: Standard.
- E. Thickness: 0.080 inch (2.0 mm).

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic cement based formulation provided or approved by floor covering manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor covering manufacturer for products and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor coverings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of floor coverings.
- B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Alkalinity and Adhesion Testing: Perform tests recommended by linoleum flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
3. Moisture Testing:
 - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
- C. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- E. Move floor coverings and installation materials into spaces where they will be installed at least 72 hours in advance of installation.
 1. Do not install floor coverings until they are same temperature as space where they are to be installed.
- F. Immediately before installation, sweep and vacuum clean substrates to be covered by flooring.

3.3 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions for installing flooring.
- B. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.
- C. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
- D. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on subfloor. Use chalk or other nonpermanent marking device.
- E. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 SHEET FLOOR COVERING INSTALLATION

- A. Unroll sheet floor coverings and allow them to stabilize before cutting and fitting.
- B. Lay out sheet floor coverings as follows:

1. Maintain uniformity of floor covering direction.
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in floor covering substrates.
3. Match edges of floor coverings for color shading at seams.
4. Avoid cross seams.
5. Eliminate deformations that result from hanging method used during drying process (stove bar marks).

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting linoleum flooring.
- B. Perform the following operations immediately after installing floor coverings:
 1. Remove adhesive and other surface blemishes from floor covering surfaces.
 2. Sweep and vacuum floor coverings thoroughly.
 3. Damp-mop floor coverings to remove marks and soil.
- C. Protect floor coverings against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended in writing by manufacturer.
 1. Apply protective floor polish to surfaces that are free of soil, visible adhesive, and surface blemishes.
 - a. Seal linoleum as recommended by manufacturer but with not less than two coats of floor polish.
 - b. Coordinate selection of floor polish with Owner's maintenance service.
 2. Cover linoleum floor coverings with undyed, untreated building paper until inspection for Substantial Completion.
 - a. Allow drying room film (yellow film caused by linseed oil oxidation) to disappear before Substantial Completion.
 3. Do not move heavy and sharp objects directly over floor covering surfaces. Place plywood or hardboard panels over floor coverings and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION 09 65 43

SECTION 09 68 13 - TILE CARPETING

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. Modular carpet tile.

- B. Related Requirements:

- 1. Section 09 65 13 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include manufacturer's written installation recommendations for each type of substrate.

- B. Shop Drawings: For carpet tile installation, plans showing the following:

- 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Carpet tile type, color, and dye lot.
 - 3. Type of subfloor.
 - 4. Type of installation.
 - 5. Pattern of installation.
 - 6. Pattern type, location, and direction.

7. Pile direction.
 8. Type, color, and location of insets and borders.
 9. Type, color, and location of edge, transition, and other accessory strips.
 10. Transition details to other flooring materials.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
1. Carpet Tile: Full-size Sample.
 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.
- D. Samples for Initial Selection: For each type of carpet tile.
1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.
- E. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
1. Carpet Tile: Full-size Sample.
 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.
- F. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- G. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer in business for 10 years.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 1. Build mockups at locations and in sizes shown on Drawings.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the Carpet and Rug Institute's CRI 104.

1.10 FIELD CONDITIONS

- A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.11 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 does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.
 - c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.
 - f. Delamination.

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

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Mannington Portella, St. Croix carpet tiles or equal approved by Architect in an addendum.
- B. Color: As selected by Architect from manufacturer's full range.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives if required: Water-resistant, mildew-resistant, nonstaining, 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.
- C. Metal Edge/Transition Strips: Extruded aluminum with finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests 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. (1.36 kg of water/92.9 sq. m) 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.

- D. Wood Subfloors: Verify the following:
 - 1. Underlayment over subfloor complies with requirements specified in Section 061600 "Sheathing."
 - 2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- E. Metal Subfloors: Verify the following:
 - 1. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- F. Painted Subfloors: Perform bond test recommended in writing by adhesive manufacturer.
 - 1. Access Flooring Systems: Verify the following:
 - 2. Access floor substrate is compatible with carpet tile and adhesive if any.
 - 3. Underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities, gaps greater than 1/8 inch (3 mm), protrusions more than 1/32 inch (0.8 mm), and substances that may interfere with adhesive bond or show through surface.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

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 (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) 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. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with the Carpet and Rug Institute's CRI 104, Section 13.7.
- C. 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 09 68 13

SECTION 09 72 00 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall coverings.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.
- B. Shop Drawings: Show location and extent of each wall-covering type. Indicate veneer matching if required, seams, and termination points.
- C. Samples for Verification: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 36-inch- (914-mm-) long in size from same production run to be used for the Work.
 1. Wall-Covering Sample 1 square yard.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For wall coverings to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 1. Wood-Veneer Wall Coverings: Condition spaces for not less than 48 hours before installation.
- B. Lighting: Do not install wall covering until a lighting level of not less than 80 fc (853 lux) is provided on the surfaces to receive wall covering.
- C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Surface-Burning Characteristics: As follows, per ASTM E 84:
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2.2 WALL COVERING

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Product indicated on Finish Legend.

2.3 ACCESSORIES

- A. Adhesive: Mildew-resistant, nonstaining, strippable adhesive, for use with specific wall covering and substrate application; as recommended in writing by wall-covering manufacturer and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Primer/Sealer: Mildew resistant, complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall-covering manufacturer for intended substrate.
- C. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended by wall-covering manufacturer.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
- D. Seam Tape: As recommended in writing by wall-covering manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.

- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
 - 1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
 - 2. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
- D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
- E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 INSTALLATION

- A. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.
- B. Install strips in same order as cut from roll.
- C. Re-inspect installation after the application of each panel.
- D. Install wall covering with no gaps or overlaps, no lifted or curling edges, no air bubbles, and no visible shrinkage.
- E. Install seams vertical and plumb at least 6 inches (150 mm) from outside corners and 6 inches (150 mm) from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.
- F. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

3.4 CLEANING

- A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended in writing by wall-covering manufacturer.
- C. Replace strips that cannot be cleaned.
- D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 09 72 00

SECTION 09 91 13 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following exterior substrates that do not have a factory applied finish:
 - 1. Steel and iron.
 - 2. Galvanized metal.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each type of paint system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches (200 mm) square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.

1.4 QUALITY ASSURANCE

- A. MPI Standards:
 - 1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 - 2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are

between 50 and 95 deg F (10 and 35 deg C).

- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Benjamin Moore & Co.
 2. PPG Architectural Finishes, Inc.
 3. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

- A. Material Compatibility:
 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2.3 METAL PRIMER

- A. Interior/Exterior Acrylic Rust-Inhibitive Maintenance Primer:
 1. VOC Content: 91 grams per liter.
 2. Dry film thickness per coat: 2.0 to 3.0 mils.
 3. Finish: 5-15 @ 85° / >5 @ 60°.
 4. Basis-of-Design Product: DVP V-Cote 200 Acrylic Maintenance Primer/Finish, MC-Series.

2.4 EXTERIOR LATEX PAINT

- A. Exterior Semi-Gloss Acrylic Latex:
 1. VOC Content: 141 grams per liter.
 2. Dry film thickness per coat: 1.5 to 2.0 mils.
 3. Finish: 30-40 @ 60°.
 4. Basis-of-Design Product: DVP Weather-Plate Exterior 100% Acrylic Latex Semi-Gloss, BH-Series.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
 - 1. Owner may engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance of paint materials with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove non-complying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

- A. Steel Substrates:
 - 1. Exterior Semi-Gloss Acrylic Latex Finish System: Provide 2 coats of finish over a water-based, rust-inhibitive primer.
 - a. Primer Coat: Interior/Exterior Acrylic Rust-Inhibitive Maintenance Primer.
 - b. Finish Coat: Exterior Semi-Gloss Acrylic Latex.

B. Galvanized-Metal Substrates:

1. Exterior Semi-Gloss Acrylic Latex Finish System: Provide 2 coats of finish over a water-based, rust-inhibitive primer.
 - a. Primer Coat: Interior/Exterior Acrylic Rust-Inhibitive Maintenance Primer.
 - b. Finish Coat: Exterior Semi-Gloss Acrylic Latex.

END OF SECTION 09 91 13

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete; seal in indicated locations.
 - 2. Concrete masonry units (CMU).
 - 3. Steel.
 - 4. Galvanized metal.
 - 5. Gypsum board and/or plaster.
- B. Related Sections include the following:
 - 1. Division 5 Sections for shop priming of metal substrates with primers specified in this Section.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:
 - 1. Product Data: For paints and coatings, indicating VOC content.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches (200 mm) square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.

1.4 QUALITY ASSURANCE

- A. Polyurethane/Acrylic Textured System Installer Qualifications: An entity with similar project experience and approved by manufacturer.
- B. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.
- C. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 50 deg F (10 deg C).
1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 80 deg F (10 and 27 deg C).
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Painting products:
 - a. Benjamin Moore & Co.
 - b. PPG Architectural Finishes, Inc.
 - c. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

- A. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience, including shop primed and galvanized items.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
1. Flat Paints and Coatings: 50 g/L.
 2. Nonflat Paints and Coatings: 150 g/L.
 3. Dry-Fog Coatings: 400 g/L.
 4. Primers, Sealers, and Undercoaters: 200 g/L.
 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 7. Pretreatment Wash Primers: 420 g/L.
 8. Floor Coatings: 100 g/L.
 9. Shellacs, Clear: 730 g/L.
 10. Shellacs, Pigmented: 550 g/L.
- C. Colors: Use of manufacturer's proprietary product names to designate colors is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. All surfaces to receive primer, intermediate coat, and final coat.
1. Refer to Room Finish Schedule on Drawings for color selections.

2.3 BLOCK FILLERS

- A. Interior/Exterior Latex Block Filler: MPI #4.

2.4 PRIMERS/SEALERS

- A. Interior Latex Primer/Sealer: MPI #50.
 - 1. VOC Content: No Zero VOC primers allowed.
- B. Primer, Alkali Resistant, Water Based: MPI #3.

2.5 METAL PRIMERS

- A. Rust-Inhibitive, Water Based Metal Primer: MPI #107.
- B. Galvanized-Metal Primer: MPI #134.

2.6 LATEX PAINTS (FOR INTERMEDIATE COAT AND FOR FINAL COAT)

- A. Interior Latex (Flat): MPI #53 (Gloss Level 1).
- B. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).
- C. Light Industrial Coating, Interior Latex (Gloss): MPI #154(Gloss Level 6).

2.7 DRY FOG/FALL COATINGS

- A. Dry Fall, Latex (Eggshell): MPI #155.

2.8 FLOOR COATINGS

- A. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete and Masonry: 12 percent
 - 2. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Protect and cover items indicated not to be painted with suitable material.
- D. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

2. Cementitious Materials: Prepare concrete, concrete unit masonry, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
 - a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
 - b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
 - c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.
- E. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- F. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- G. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, rust, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.
 1. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 6/NACE No. 3.
 2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 3. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth, and dust has been removed.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 1. Use applicators and techniques suited for paint and substrate indicated.
 2. Paint colors, surface treatments, and finishes are indicated in the paint schedules.

3. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 4. Provide prime coats that are compatible with substrate material. Provide finish coats that are compatible with primers used.
 5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
 6. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 7. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
 8. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 9. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 10. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
 11. Sand lightly between each succeeding enamel or varnish coat.
- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 2. Omit primer over metal surfaces that have been shop primed and touchup painted.
 3. If undercoats, stains, pin holes in masonry, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide

sufficient difference in shade of undercoats to distinguish each separate coat.

- F. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- G. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.
- H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.
- I. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- J. Second and Third Coats: Two individual finish coats are required, for a total of three coats (minimum). First coat is the primer; second and third coats are referred to in the schedule that follows in Part 3 as the "Intermediate" and "Top" coats. "Backrolling" is not an acceptable method of providing the top coat. Apply each coat so that it completely covers the entire surface being painted and allow it to dry before applying the next coat.
- K. Touch-Ups: Touch-up painting to include painting of entire surface, corner to corner. Spot touch-up not allowed.
- L. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- M. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
- N. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
- O. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- P. Painting Mechanical and Electrical Work: Paint items exposed in occupied spaces including, but not limited to, the following:
 - 1. Mechanical Work:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.
 - d. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.

- e. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - f. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
2. Electrical Work:
- a. Switchgear.
 - b. Panelboards.
 - c. Electrical equipment that is indicated to have a factory-primed finish for field painting.
- Q. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
1. Prefinished items include the following factory-finished components:
- a. Architectural woodwork.
 - b. Acoustical wall panels.
 - c. Finished mechanical and electrical equipment.
 - d. Light fixtures.
2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
- a. Foundation spaces.
 - b. Furred areas.
 - c. Ceiling plenums.
 - d. Pipe spaces.
 - e. Duct shafts.
3. Finished metal surfaces include the following:
- a. Anodized aluminum.
 - b. Stainless steel.
 - c. Chromium plate.
 - d. Copper and copper alloys.
 - e. Bronze and brass.
4. Operating parts include moving parts of operating equipment and the following:
- a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
 - e. Sprinkler heads.
5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

3.4 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance of paint materials with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

- B. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. Protect items indicated not to be painted against damage from paint application and from receiving paint. This includes sprinkler heads at exposed areas and gypsum board ceilings. Replace any sprinkler head that gets paint on it.
- E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. CMU Substrates:
 - 1. Latex System: MPI INT 4.2A.
 - a. Prime Coat: Interior/exterior latex block filler.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Light industrial coating, interior latex, water based, gloss (Gloss Level 6).

- B. Concrete Substrates, Traffic Surfaces SC-1:

1. Water-Based Clear Sealer System: MPI INT 3.2G.
 - a. First Coat: Interior/exterior clear concrete floor sealer (water based).
 - b. Topcoat: Interior/exterior clear concrete floor sealer (water based).

- C. Steel Substrates:
 1. Dry Fog/Fall Coatings: Provide 1 coat of finish over primer.
 - a. Primer Coat: Primer, rust-inhibitive, water based.
 - b. Finish Coat: Latex Dry Fall (Eggshell).

 2. Water-Based Light Industrial Coating System:
 - a. Prime Coat: Primer, rust-inhibitive, water based.
 - b. Intermediate Coat: Light industrial coating, interior latex, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, interior latex, water based, gloss (Gloss Level 6).

- D. Galvanized-Metal Substrates:
 1. Water-Based Light Industrial Coating Over Waterborne Primer System:
 - a. Prime Coat: Primer, galvanized, water based.

 - b. Intermediate Coat: Light industrial coating, interior latex, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, interior latex, water based, gloss (Gloss Level 6).

- E. Gypsum Board Substrates:
 1. Latex System: MPI INT 9.2A.
 - a. Prime Coat: Interior latex primer/sealer (white in color).
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex. (sheen as indicated on Drawings).

END OF SECTION 09 91 23

SECTION 09 93 00 - STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and application of wood finishes on the following substrates:
 - 1. Interior Substrates:
 - a. Including wood trim and architectural woodwork.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.
- B. Sustainable Design Submittals:
 - 1. Product Data: For paints and coatings, indicating VOC content.
- C. Samples for Initial Selection: For each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each finish system indicated and each color selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each type of finish system and substrate.
 - a. Other Items: Architect will designate items or areas required.
 - 2. Final approval of stain color selections will be based on mockups.
 - a. If preliminary stain color selections are not approved, apply additional mockups of additional stain colors selected by Architect at no added cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply finishes when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Benjamin Moore & Co.
 - 2. PPG Architectural Finishes, Inc.
 - 3. Sherwin-Williams Company (The).

2.2 MATERIALS, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.
- B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior stains and finishes applied at project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 1. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 - 2. Stains: VOC not more than 250 g/L.
 - 3. Primers, Sealers, and Undercoaters: 200 g/L.

C. Stain Colors:

1. Interior: Match Architect's sample

2.3 STAIN

A. Interior Wood Stain:

1. Sherwin-Williams; Minwax 250 VOC Stains.

2.4 POLYURETHANE

A. Polyurethane, Moisture Cure, Clear: Satin.

1. Sherwin-Williams; Wood Classic WB Polyurethane, A68 Series.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Interior Wood Substrates: 15 percent, when measured with an electronic moisture meter.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with finish application only after unsatisfactory conditions have been corrected.
 1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
 1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

- C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
 - 2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

- D. Interior Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Scrape by hand-tool cleaning methods to remove loose finish until only tightly adhered finish remains.
 - 3. Apply wood filler paste to open-grain woods, as defined in "MPI Architectural Painting Specification Manual," to produce smooth, glasslike finish.
 - 4. Sand surfaces that will be exposed to view and dust off.
 - 5. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

- A. Apply finishes according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for finish and substrate indicated.
 - 2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.

- B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

- B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

- C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

- D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. Wood substrates, nontraffic surfaces, including architectural woodwork and wood panel products.

1. Polyurethane Varnish over Stain System:

- a. Stain Coat: Stain, semi-transparent, for interior wood.
- b. First Intermediate Coat: Polyurethane varnish matching topcoat.
- c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
- d. Topcoat: Varnish, interior, polyurethane, oil-modified, satin (Gloss Level 4).
- e. Topcoat: Varnish, interior, polyurethane, oil-modified, gloss (Gloss Level 6).

END OF SECTION 09 93 00

SECTION 09 96 00 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and application of high-performance coating systems on the following substrates:

- 1. Interior Substrates:
 - a. Concrete.
 - b. Concrete masonry units (CMU).

- B. Related Requirements:

- 1. Division 09 painting Sections for special-use coatings and general field painting.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

- B. Sustainable Design Submittals:

- 1. Product Data: For paints and coatings, indicating VOC content.

- C. Samples for Initial Selection: For each type of topcoat product indicated.

- D. Product List: For each product indicated, include the following:

- 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
- 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
- 3. VOC content.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.5 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

B. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each coating system specified in Part 3.
 - a. Wall/Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Benjamin Moore & Co.
 - 2. PPG Architectural Finishes, Inc.
 - 3. Sherwin-Williams Company (The).
- B. Colors: Use of manufacturer's proprietary product names to designate colors is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers.
 - 1. Refer to Room Finish Schedule on Drawings for color selections.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
 - 3. Provide products of same manufacturer for each coat in a coating system.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior coatings applied at project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 150 g/L.
 - 3. Primers, Sealers, and Undercoaters: 200 g/L.
 - 4. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: 250 g/L.
 - 5. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 - 6. Pre-Treatment Wash Primers: 420 g/L.
 - 7. Floor Coatings: 100 g/L.
 - 8. Shellacs, Clear: 730 g/L.
 - 9. Shellacs, Pigmented: 550 g/L.

2.3 BLOCK FILLERS

- A. Block Filler, Epoxy: MPI #4.
 - 1. Basis of Design; Sherwin Williams; PrepRite Masonry Primer.

2.4 EPOXY COATINGS

- A. Epoxy-Modified Latex, Interior, Gloss (Gloss Level 6): MPI #115.
 - 1. Basis of Design; Sherwin Williams; Water Based Catalyzed Epoxy.

2.5 SOURCE QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - a. Concrete: 12 percent.
 - b. Masonry (Clay and CMU): 12 percent.
- B. Concrete and Masonry Substrates: Verify that concrete and grout is fully cured.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 to 27 580 kPa) at 6 to 12 inches (150 to 300 mm).
 - 2. Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
- E. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions.
 - 1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 to 27 580 kPa) at 6 to 12 inches (150 to 300 mm).

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - 2. Omit primer over metal surfaces that have been shop primed and touchup painted.

3. If undercoats, stains, pin holes in masonry, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- F. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- G. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.
- H. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.
- I. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.
- J. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- K. Second and Third Coats: Two individual finish coats are required, for a total of three coats (minimum). First coat is the primer; second and third coats are referred to in the schedule that follows in Part 3 as the "Intermediate" and "Top" coats. "Backrolling" is not an acceptable method of providing the top coat. Apply each coat so that it completely covers the entire surface being painted and allow it to dry before applying the next coat.

- L. Touch-Ups: Touch-up painting to include painting of entire surface, corner to corner. Spot touch-up not allowed.
- M. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- N. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
- O. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance of paint materials with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.
- B. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
 - 1. Contractor shall touch up and restore coated surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates:

1. Epoxy-Modified Latex System:

- a. Prime Coat: Epoxy-modified latex, interior, gloss (Gloss Level 6), MPI #115.
- b. Intermediate Coat: Epoxy-modified latex, interior, gloss (Gloss Level 6), MPI #115.
- c. Topcoat: Epoxy-modified latex, interior, gloss (Gloss Level 6), MPI #115.

B. CMU Substrates:

1. Epoxy-Modified Latex System:

- a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
- b. Intermediate Coat: Epoxy-modified latex, interior, gloss (Gloss Level 6), MPI #115.
- c. Topcoat: Epoxy-modified latex, interior, gloss (Gloss Level 6), MPI #115.

END OF SECTION 09 96 00

SECTION 10 11 00 - VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Marker boards.
 - 2. Glass markerboards.
 - 3. Tack boards.
 - 4. Visual display rails.

1.3 DEFINITIONS

- A. Tack board: Framed or unframed tackable surface.
- B. Visual Display Boards: Chalkboards, marker boards, and tack boards.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of visual display surface indicated and as follows:
 - 1. Actual sections of tack board assembly and display rail.
 - 2. Samples of accessories involving color selection.
- C. Maintenance Data: For visual display surfaces to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain all specified types of visual display surfaces through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of visual display surfaces and are based on the specific system indicated. Refer to Division 1 Section "Material and Equipment."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

- C. Fire-Test-Response Characteristics: Provide fabrics with the surface-burning characteristics indicated, as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-built visual display boards, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
- B. Store visual display units vertically with packing materials between each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Product: Subject to compliance with requirements, provide product specified.

2.2 MATERIALS, GENERAL

- A. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
- B. Composite Wood Products: Products shall be made without urea formaldehyde.
- C. Hardboard: AHA A135.4, tempered.
- D. Particleboard: ANSI A208.1, Grade 1-M-1, made with binder containing no urea formaldehyde.
- E. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish with surface-burning characteristics indicated.

- F. Plastic-Impregnated Cork Sheet: MS MIL-C-15116-C, Type I, seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto burlap backing; with washable vinyl finish and integral color throughout.
- G. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.

2.3 MARKER BOARD ASSEMBLIES

- A. Porcelain-Enamel Marker board Assembly: Balanced, high-pressure, factory-laminated marker board assembly of 3-ply construction consisting of backing sheet, core material, and 0.021-inch (0.53-mm) thick, porcelain-enamel face sheet with low-gloss finish.
 - 1. Manufacturer's Standard Core: Minimum 1/4 inch (6 mm) thick, with manufacturer's standard moisture-barrier backing.
 - 2. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.
 - 3. Size: Marker board assemblies shall be 4'-0" h x the length indicated on the Drawings. Mount top of units 7'-0" above floor.
 - 4. Gloss Finish: Low gloss; dry-erase markers wipe clean with dry cloth or standard eraser. Suitable for use as projection screen.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ADP Lemco, Inc.
 - 2. Best-Rite Manufacturing.
 - 3. Claridge Products and Equipment, Inc.
 - 4. Ghent Manufacturing, Inc.
 - 5. PolyVision Corporation; a Steelcase company.

2.4 TACK BOARD ASSEMBLIES

- A. Plastic-Impregnated-Cork Tack Assembly: 1/4-inch- (6-mm-) thick, plastic-impregnated cork sheet factory laminated to 1/4-inch- (6-mm-) thick hardboard backing.
 - 1. Size: Tack board assemblies shall be 4'-0" h x the length indicated on the Drawings.

2.5 VISUAL DISPLAY RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ADP Lemco, Inc.
 2. Best-Rite Manufacturing.
 3. Claridge Products and Equipment, Inc.
 4. Ghent Manufacturing, Inc.
 5. PolyVision Corporation; a Steelcase company.
- B. General: Manufacturer's standard, aluminum-framed, tackable cork visual display surface fabricated into narrow rail shape and designed for displaying material.

2.6 MARKER BOARD AND TACK BOARD ACCESSORIES

- A. Manufacturers:
1. ADPLemco, Inc.
 2. Best-Rite Manufacturing.
 3. Claridge Products & Equipment, Inc.
 4. Ghent Manufacturing Inc.
 5. PolyVision Corporation.
- B. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch (1.57-mm) thick, extruded aluminum; of size and shape indicated.
1. Factory-Applied Trim: Manufacturer's standard.
- C. Provide the following accessories:
1. Display Rail: Continuous and integral with map rail; fabricated from cork approximately 1 to 2 inches (25 to 50 mm) wide.
 2. End Stops: Located at each end of map rail.
 3. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches (1220 mm) of map rail or fraction thereof.
 4. Paper Holder: Extruded aluminum; designed to hold paper by clamping action.
- D. Chalk tray: Manufacturer's standard, continuous.
1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.

2.7 FABRICATION

- A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
- B. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to neat, hairline closure.
 - 1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Examine walls and partitions for proper backing for visual display surfaces.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.

- B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.
 - 1. Remove dirt, scaling paint, projections, and depressions that will affect smooth, finished surfaces of visual display boards.

3.3 INSTALLATION, GENERAL

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, brackets, anchors, trim, and accessories necessary for complete installation.
 - 1. Mounting Height: 32 inches (812 mm) above finished floor to top of chalktray.
- B. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches (400 mm) o.c. Secure both top and bottom of boards to walls.
- C. Display Rails: Install rails in locations and at mounting heights indicated on Drawings. Attach to wall surface with fasteners at not more than 16 inches (400 mm) o.c.

3.4 CLEANING AND PROTECTION

- A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 101100

SECTION 10 12 00 - DISPLAY CASES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes the following:
 - 1. Illuminated display cases.
- B. Related Sections include the following:
 - 1. Division 4 Section "Unit Masonry" for wall construction.
 - 2. Division 6 Section "Miscellaneous Rough Carpentry" for blocking.
 - 3. Division 10 Section "Visual Display Surfaces" for tackboards.
 - 4. Division 26 Sections for wiring and other electrical work associated with illuminated display cases.

1.3 DEFINITIONS

- A. Bulletin Board: Tackable visual display surface or tackboard enclosed in a display case.
- B. Display Case: Glazed cabinet with visual display surface background and adjustable shelves.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for display cases.
- B. Shop Drawings: For display cases. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show location of seams and joints in visual display surfaces.
 - 2. Include sections of typical trim members.
 - 3. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes, and as follows:
 - 1. Actual sections of visual display surfaces.
 - 2. Section of header panel for color selection.
- D. Samples for Verification: For each type of product indicated.

1. Visual Display Surface: Not less than 8-1/2 by 11 inches (215 by 280 mm), mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
 2. Trim: 6-inch- (152-mm-) long sections of each trim profile including corner section.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.
- F. Maintenance Data: For visual display surfaces, operating hardware, and illuminated units to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain display cases from single source from single manufacturer.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Pre-installation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install display cases until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings 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.
- B. Field Measurements: Verify actual dimensions of openings for display cases by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Hardwood Plywood: HPVA HP-1.
- B. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish.
- C. Extruded-Aluminum Bars and Shapes: ASTM B 221 (ASTM B 221M), Alloy 6063.
- D. Aluminum Tubing: ASTM B 429, Alloy 6063.

- E. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering, and 6 mm thick unless otherwise indicated.
- F. Fasteners: Provide screws, bolts, and other fastening devices made from same material as items being fastened, except provide hot-dip galvanized, stainless-steel, or aluminum fasteners for exterior applications. Provide types, sizes, and lengths to suit installation conditions. Use security fasteners where exposed to view.

2.2 DISPLAY CASE (TROPHY CASE)

- A. Basis-of-Design Product: The design for the display case (trophy case) is based on Claridge Products and Equipment, Inc., 390 Series Large Door Recessed Display Cases. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
 - 1. Platinum Visual Systems; a division of ABC School Equipment, Inc.
 - 2. Poblocki Sign Company.
 - 3. The Tablet and Ticket Co.
- B. Recessed Cabinet: Factory-fabricated cabinet; with tackboard assembly on back inside surface, operable glazed doors at front, and trim on face to cover edge of recessed opening.
 - 1. Cabinet Box: Hardwood veneer plywood.
 - 2. Cabinet Frame and Trim: Aluminum.
 - 3. Veneer Species: Red oak with transparent finish.
 - 4. Aluminum Finish: Clear anodic.
- C. Glazed Sliding Doors: Tempered glass; framed; with extruded-aluminum top and bottom track; supported on nylon or ball-bearing rollers; with plastic top guide and rubber bumpers. Equip each door with finger pull and adjustable cylinder lock with two keys.
 - 1. Thickness: Not less than 6 mm thick.
 - 2. Number of Doors: As indicated by manufacturer's model number(s).
- D. Shelves: 6-mm-thick tempered glass; supported on adjustable shelf standards and supports.
 - 1. Shelf Width: 12 inches (300 mm).
 - 2. Number of Shelves: Three per display case unit.
- E. Adjustable Shelf Standards and Supports: BHMA A156.9, B04102; with shelf brackets, B04112; recess mounted in rear surface. Provide standards full height of display case.
- F. Tack Surface: Natural-cork tackboard assembly.
- G. Illumination System: Concealed top-lighting system consisting of fluorescent-strip fixtures. Include lamps and internal wiring with single concealed electrical connection to building system. Coordinate electrical characteristics with power supply provided.
 - 1. Ballasts: Low-temperature, high-power-factor, low-energy, fluorescent lamp ballasts that comply with Certified Ballast Manufacturers Association standards and carry its label.
- H. Width:

1. Corridor 149, south of Door No. 151B entrance to gymnasium:
 - a. Claridge 399 (2) side by side; adjust trim between units. May be combined as a single unit.
2. Corridor 149, north of Door No. 151B entrance to gymnasium:
 - a. Claridge 394 left; Claridge 395 center and Claridge 394 right; adjust trim between units. May be combined as a single unit.

I. Height: 72 inches (1800 mm).

J. Depth: 24 inches (600 mm).

2.3 FABRICATION

- A. Fabricate display cases to requirements indicated for dimensions, design, and thickness and finish of materials.
- B. Use metals and shapes of thickness and reinforcing to produce flat surfaces, free of oil-canning, and to impart strength for size, design, and application indicated.
- C. Fabricate cabinets and door frames with reinforced corners, mitered to a hairline fit, with no exposed fasteners.
- D. Fabricate shelf standards plumb and at heights to align shelf brackets for level shelves.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, with Installer present, for compliance with requirements for installation

tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

- B. Examine roughing-in for electrical power system to verify actual locations of connections before installation of illuminated units.
- C. Examine walls and partitions for proper backing for display cases.
- D. Examine walls and partitions for suitable framing depth for recessed units.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for display cases as required by type and size of unit.

3.3 INSTALLATION

- A. General: Install units in locations and at mounting heights indicated on Drawings, or where not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
 - 1. Mounting Height: 32 inches above finished floor to bottom of cabinet rough opening.
- B. Bulletin Boards: Attach units to back wall of display case with manufacturer's standard concealed hardware.
- C. Recessed Display Cases: Attach units to wall framing with fasteners at not more than 16 inches (400 mm) o.c. Attach aluminum trim over edges of recessed display cases and conceal grounds and clips. Attach trim with fasteners at not more than 24 inches (600 mm) o.c.
- D. Comply with requirements in Division 26 for connecting illuminated display cases.
 - 1. After installation is complete, install new fluorescent lamps.
- E. Install display case shelving level and straight.

3.4 ADJUSTING AND CLEANING

- A. Adjust doors to operate smoothly without warp or bind and so contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 10 12 00

SECTION 10 14 00 – PANEL SIGNAGE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Room Identification and Directional Signage: Contractor to provide identifying devices in accordance with the Architectural Drawings and Specifications to include interior sign panels and frames for room identification and direction throughout the building.

1.2 RELATED SECTIONS

- A. Section 09 91 23 – Interior Painting

1.3 SUMMARY

- A. This Section includes the following types of signs:

- 1. Panel signs with frames.

1.4 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for each type of sign specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- C. Sustainable Design Submittals:
 - 1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
- D. Shop drawings showing fabrication and erection of signs. Include plans, elevations, and large-scale sections of typical members and other components. Show anchors, grounds, layout, reinforcement, accessories, and installation details.
 - 1. Provide message list for each sign required, including large-scale details of wording and lettering layout.
 - 2. For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed as unit of Work in other Sections.

3. Templates: Furnish full-size spacing templates for individually mounted dimensional letters and numbers.
- E. Samples: Provide the following samples of each sign component for verification of color, pattern and surface texture as required and for verification of compliance with requirements indicated.
1. Selection of color, pattern, and texture:
 - a) Cast Acrylic Sheet: Manufacturer's color charts consisting of actual sections of material including the finish as indicated in this specification section (2.6).
 - b) Aluminum: Samples of each finish type and color, on 6-inch-long sections of extrusions and not less than 4-inch squares of sheet or plate, showing the finish as follows: brushed aluminum.
- F. Fabrication: Fabrication shall not begin until the Owner and Architect have approved all submittals in writing.

1.5 QUALITY ASSURANCE

- A. Single-Source Responsibility: For each separate sign type required, obtain signs from one source of a single manufacturer.
- B. 5 Years Experience: All work performed within this section, including fabrication and installation, shall be by a firm with a minimum of 5 years experience in the architectural sign industry, and specifically, in the manufacture of architectural identification with raised letters, numbers and Braille.
- C. Requirements of Regulatory Agencies: Install sign panels in accordance with the governing building codes and ordinances, including but not limited to the applicable edition of the Illinois Accessibility Code and the 2010 ADA Standards for Accessible Design. Background and text color contrast requirements must be met.
- D. Regulatory Revisions: It is the responsibility of the Sign Contractor to incorporate all revised or additional regulations that are enacted and in effect at the time of manufacturing. Additional manufacturing costs shall be subject to proof and written change order request submitted to Owner.
- E. Guarantee: All components shall be guaranteed against faulty materials and workmanship for a minimum period of 1 year after date of acceptance, unless longer guarantee is specified for the individual item. Work that gives evidence of defect within the guarantee period shall be replaced or satisfactorily repaired, without additional cost to the Owner, as part of this contract.
- F. Uniformity of Manufacturer: Products of single manufacturer shall be provided for each sign system.

- G. Provide installed mock-up for "C" type sign after removal of existing sign and wall patch and paint.
- H. Attend designated pre-installation meeting.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

1.7 PRODUCT DELIVERY

- A. Delivery and Storage: Deliver signs, frames and all components in a timely manner for installation without causing delay. Components shall be stored in a manner to prevent damage to the contents.
- B. Damage: Any damage to the signs and accessories, prior to acceptance and not a result of vandalism, will be cause for their rejection, requiring replacement at no additional cost to the Owner.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ASI Sign Systems, Inc.
 - 2. Best Manufacturing Company
 - 3. Mohawk Sign Systems
 - 4. Poblocki & Sons, Inc.
 - 5. Spanjer Brothers, Inc.

2.2 MATERIALS

- A. Cast Acrylic Sheet: Provide cast (not extruded or continuous cast) methyl methacrylate monomer plastic sheet, in sizes and thicknesses indicated, with a minimum flexural strength of 16,000 psi when tested according to ASTM D 790, with a minimum allowable continuous service temperature of 176 degrees F, and of the following general types:
 - 1. Opaque Sheet: Where sheet material is indicated as "opaque", provide colored opaque acrylic sheet in colors and finishes indicated.

- B. Aluminum Extrusions: Provide aluminum extrusions of allow and temper recommended by the sign manufacturer for the type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B 221 for6063-T5.
- C. Fasteners: Use concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surfaced.

2.3 PANEL SIGNS

- A. Regional Materials: Products shall be manufactured within 500 miles (800 km) of Project site.
- B. Panel Signs: Comply with Requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
- C. Framed Panel Signs: Fabricate frames to profile indicated; comply with the following requirements for materials and corner conditions.
 - 1. Material: Acrylic plastic.
 - 2. Corner Conditions: Square corners.
- D. Graphic Content and Style: Provide sign copy that complies with the requirements indicated for size, style, spacing, content, position, material, finishes, and colors of letters, numbers, and other graphic devices.
- E. Raised Copy: Machine cut-copy characters from matte-finished opaque acrylic sheet and chemically weld onto the acrylic sheet forming sign panel face. Produce precisely formed characters with square cut edges free from burrs and cut mark.
 - 1. Panel Material: Matte-finished opaque sheet.
 - 2. Raised Copy Thickness: 3/16inch.
- F. Grade 2 Braille characters to appear in accordance with Accessibility Regulation, with reference to position, size and configuration. Characters to have smooth edges, as opposed to edges that are sharp. Braille location: center justify under room numbers. Left justify under othertext.
- G. Acceptable graphic processes listed below from most to least desirable will provide photo-mechanical and/or computer-generated graphic process to be selected from only one of the following.
 - 1. Photo etch nylon-polymer.
 - 2. Photo sandblast.
 - 3. Plasticengraving.
- H. Typeface: Optima semi-bold, Capital letter minimum height of 3/4". Inserts may utilize upper and lower case. (See SignageSchedule).

- I. Panel Thickness: 1/8" to 3/16" plus raised image graphics.
- J. Panel Frame:
 - 1. Material: Aluminum extruded or cast.
 - a. 1/16" x 1/2" aluminum angle perimeter, with pressboard back, square corners and counterstunk holes for installation of room name; 1/16" x 3/8" aluminum angle for symbol
 - b. Frame size to be minimum of 1/16" and maximum of 1/8" larger than the sign panel in both height and width to allow for a reveal between panel and frame.
 - c. Frame shall include 1/16" aluminum divider between Number and Function panels, or as indicated on drawings.
- K. Panel Size:
 - 1. Refer to Architect's detail drawings.
 - 2. Should message schedule include graphic copy that exceeds specifications indicated, panel size may be increased accordingly, but field conditions shall be verified for sufficient space to accept sign panel.
- L. Braille Location:
 - 1. Center justify under room numbers.
 - 2. Right justify under room identification or other text.
- M. Paper Inserts: Provide paper inserts with text as indicated on the sign types and schedule.
- N. Glass back-up panels fabricated of same material and color as sign panels for signs installed on glass. Glass back-up panels to be same size as signage frame.

2.6 FINISHES

- A. Background colors shall be selected from Pantone Matching System (PMS). Sample of actual paint to be used, applied to 4" by 4" minimum scrap of actual sign material, shall be provided for review and approval prior to use.
- B. Metal Finishes: Comply with NAAMM "Metal Finishes Manual: for finishes designations and applications recommendations.
- C. Aluminum Finishes: Finish designations prefixed with "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
 - 1. Baked-Enamel Finish: AA-M4xC12C42R1x (Mechanical Finish: Manufacturer's standard, other non-directional textured; Chemical Finish: Chemical conversion coating, acide cromate-fluorife-phosphate pretreatment; Organic Coating: as specified below). Apply baked enamel in compliance with paint manufacturer's specifications for cleaning, conversion coating, and painting.
 - a. Organic Coating: Thermosetting-modified acrylic enamel primer/topcoat

system complying with AAMA 603.8 except with a minimum dry film thickness of 1.5 mils, medium gloss.

- 1) Standard Signage:
 - a) Color: Light background with dark grey text/symbols; Pantone numbers to be determined.

PART 3 – EXECUTION

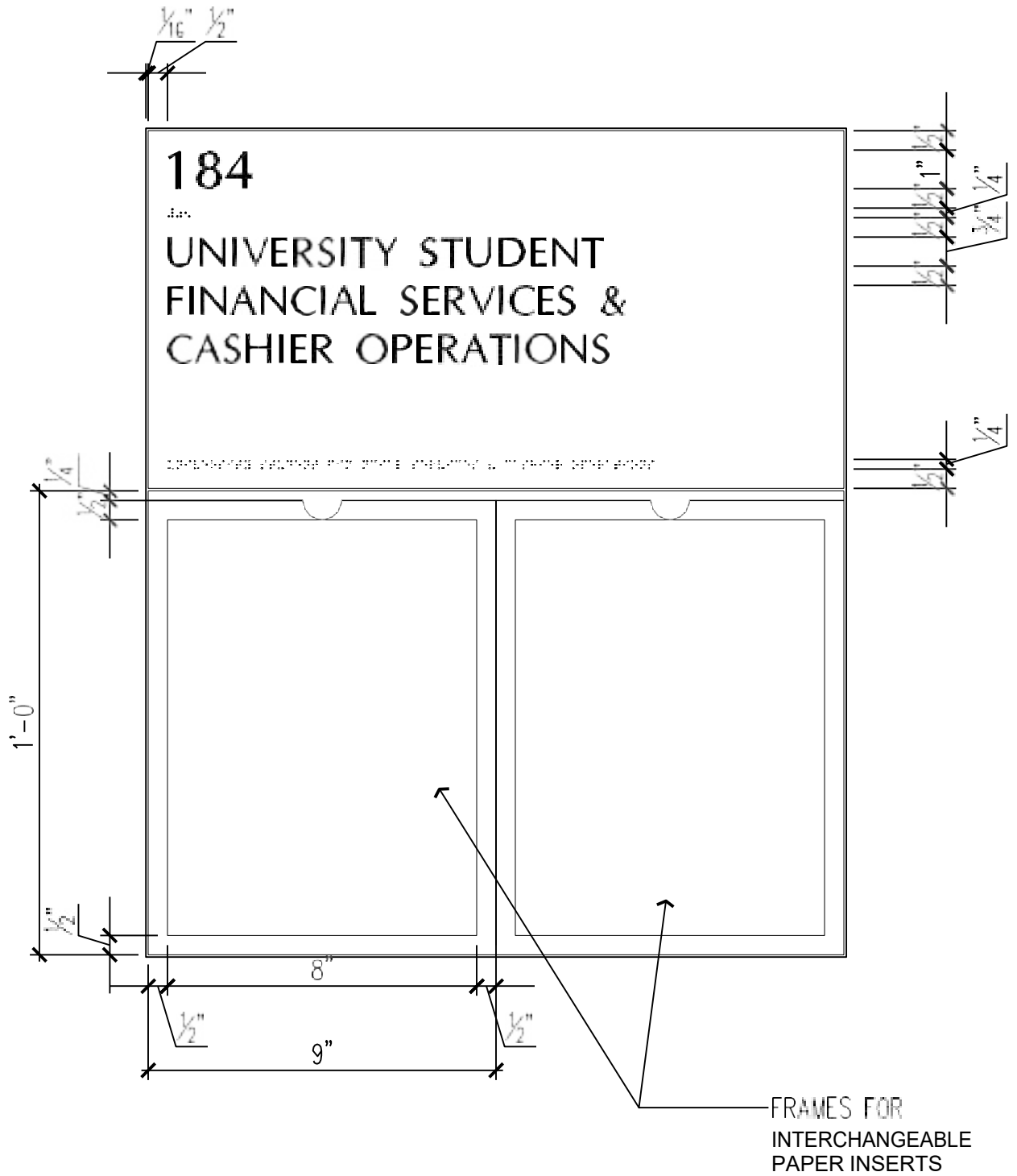
3.1 INSTALLATION

- A. General: Locate sign units and accessories where indicated, using mounting methods of the type describe and in compliance with the manufacturer's instructions.
 1. Install signs level, plumb, and at the height indicated with sign surfaces free from distortion or other defects in appearance. Sign frames and panels to be installed on the latch side of the door, 2" to 3" from the door jamb and at a height of 60" to the center of the sign panel as measured from the floor level.
- B. Wall-Mounted Panel Signs: Attach panel signs to wall surfaces using the methods indicated below:
 1. Frames: Screw frames to wall, drywall and masonry.
 2. Signs: Use double-sided foam tape to mount signs to frames.
- C. Wall-Mounted Panel Signs:
 1. Stand-offs for mounting frames are required on stone walls. Contractor field verify locations.

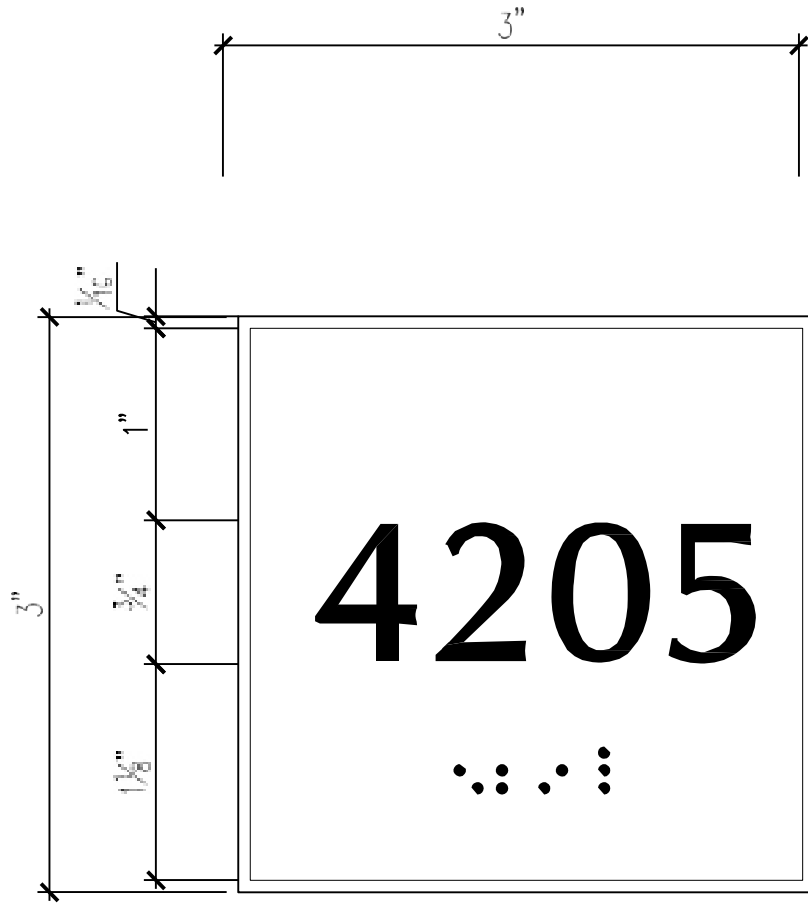
3.2 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect until free from damage until acceptance by the Owner.

TYPICAL SIGNAGE TEMPLATES:

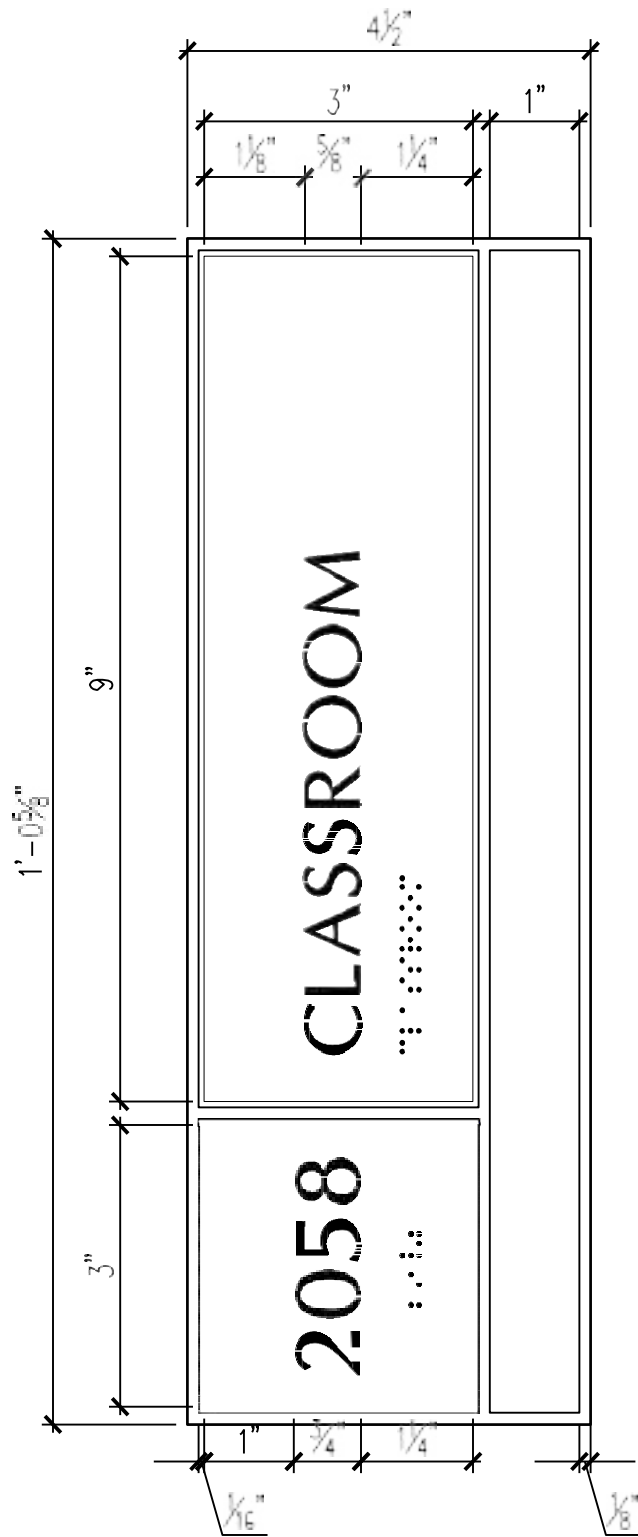






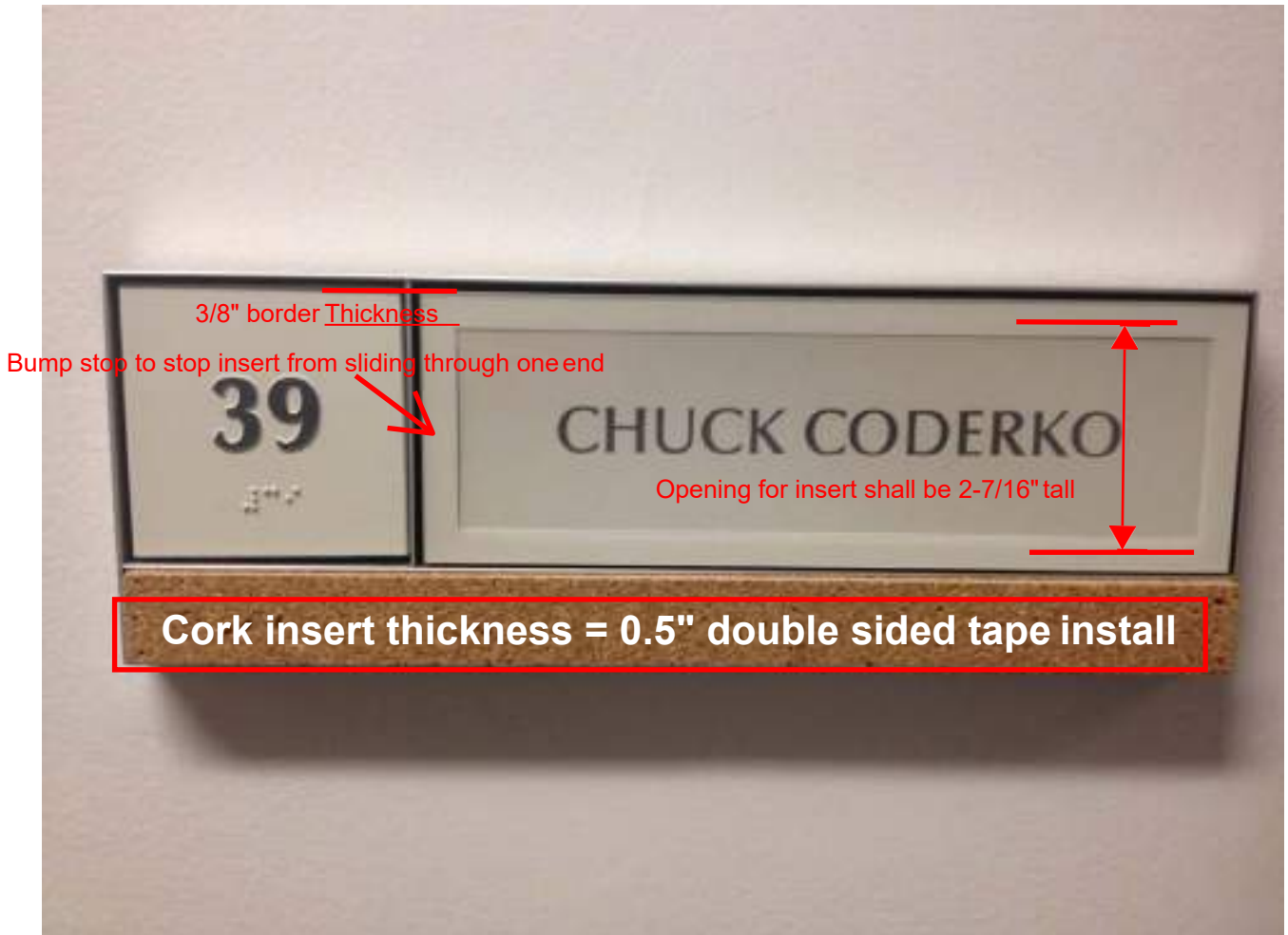
Sign Type: C1

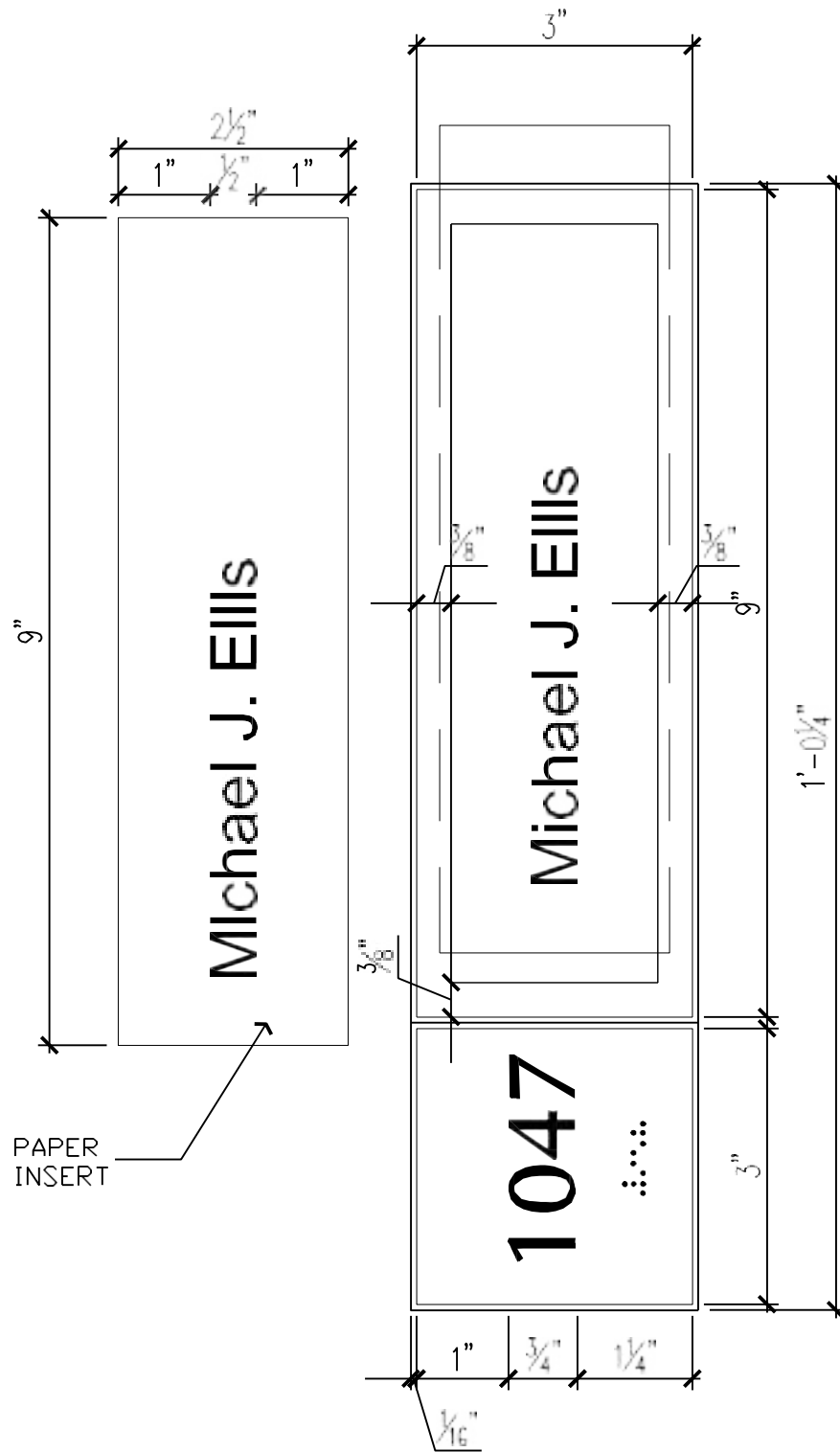




Sign Type: C2a – permanent panel Sign Type:
C2b – clear insert panel

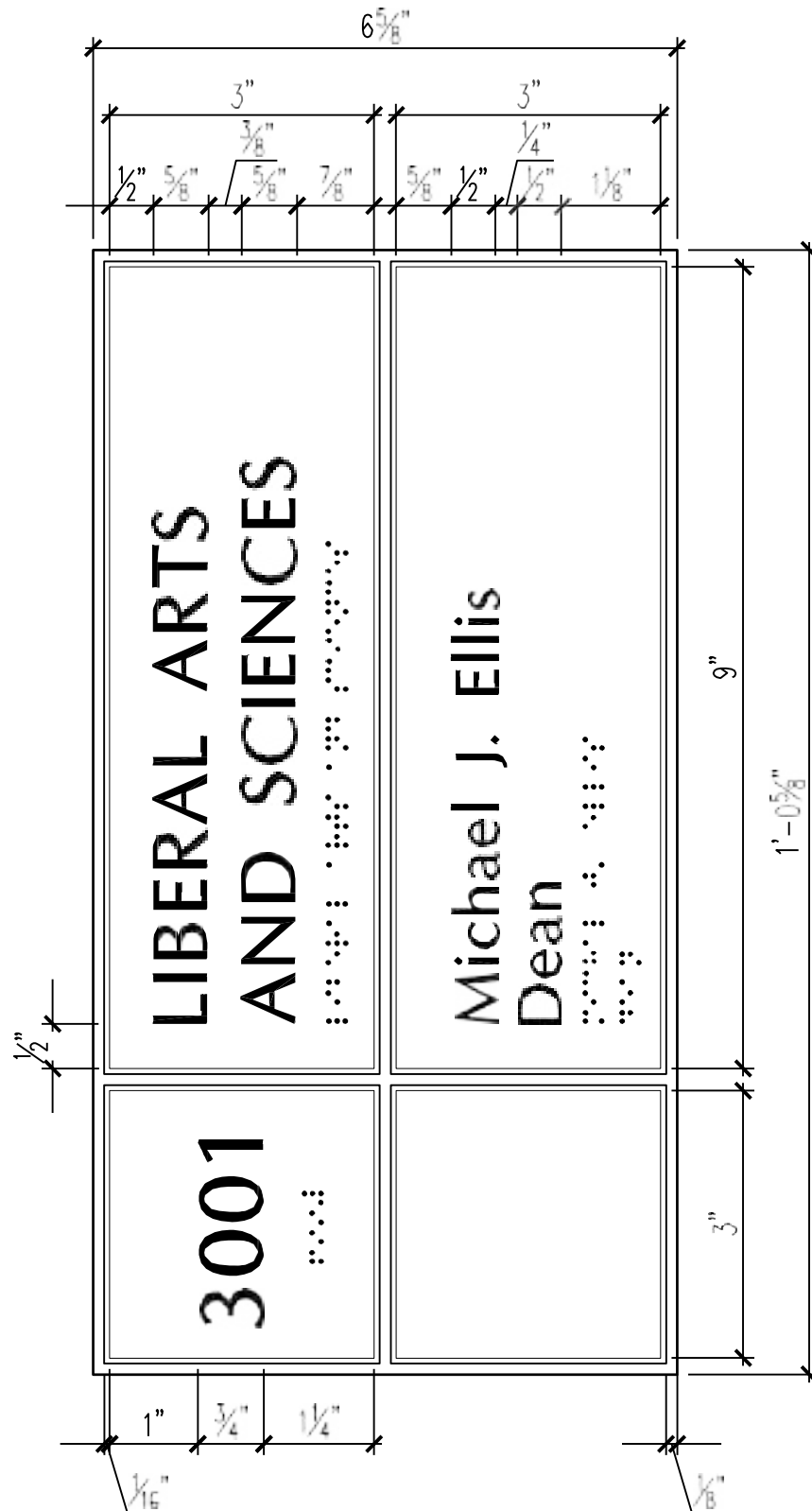






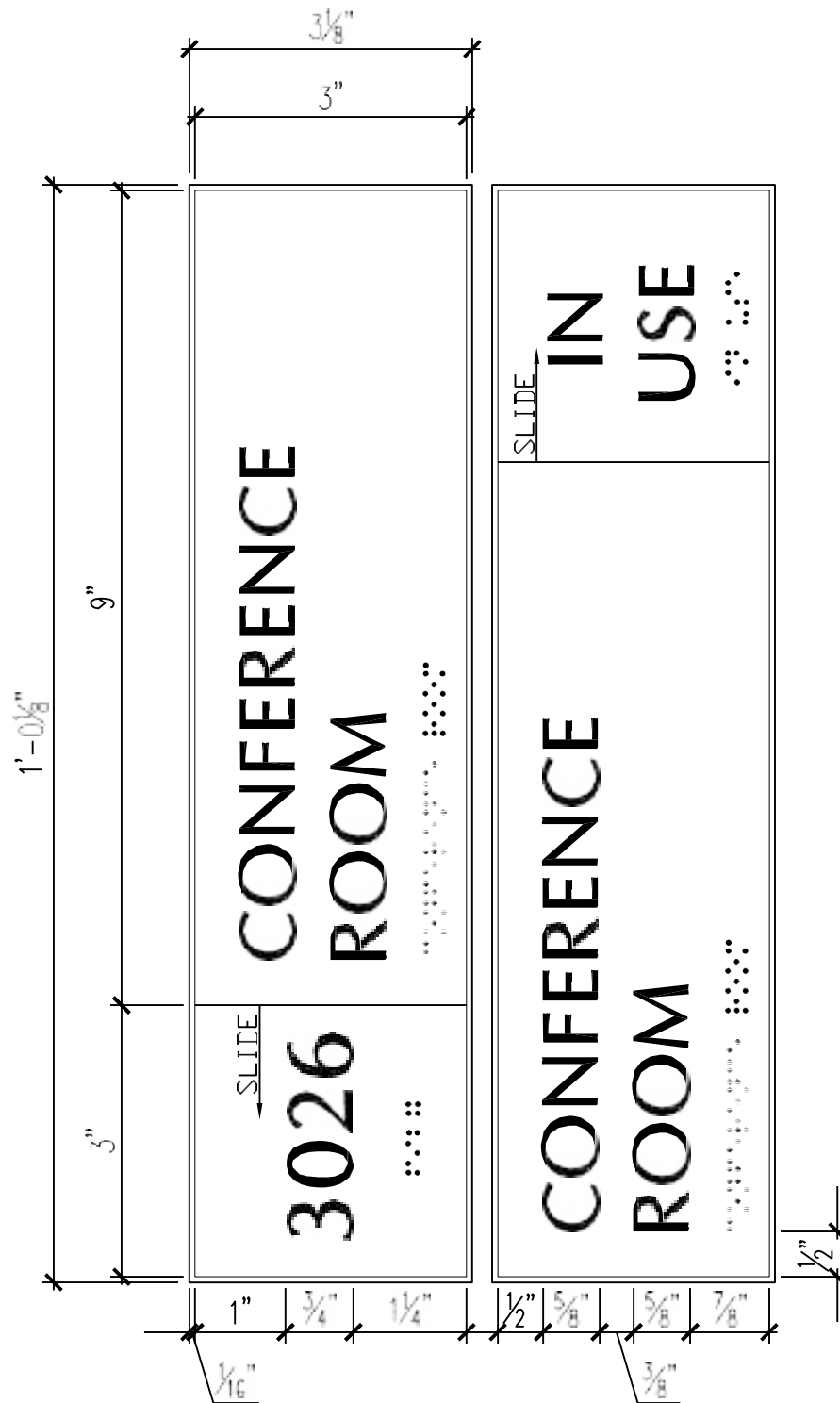
Sign Type: C3





Sign Type: C4

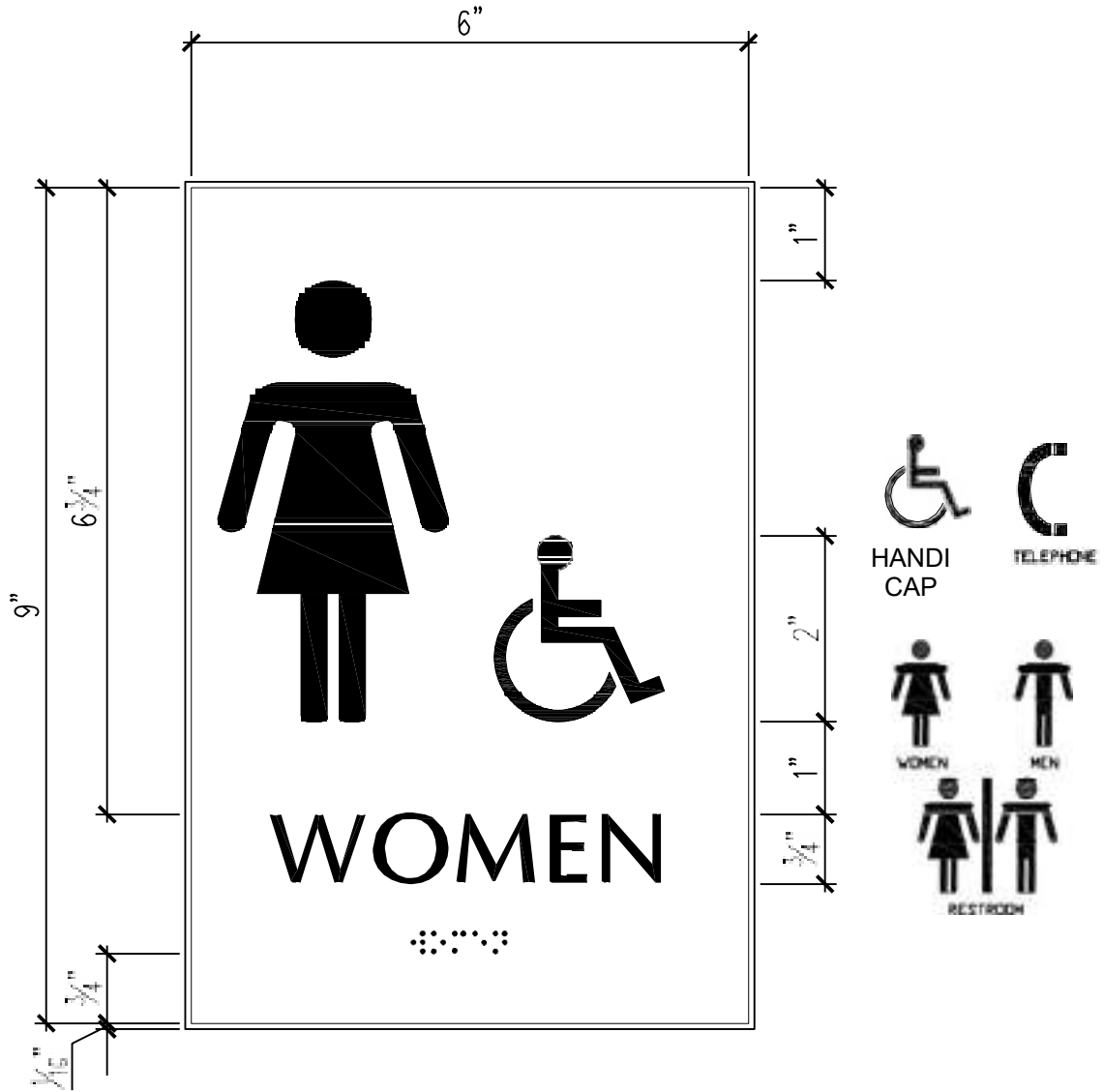




Sign Type: C5



PANEL SIGNAGE



Sign Type: C6





Sign Type: C10
Sign Type: C10b – Double-Sided, No Braille, Projecting Sign



END OF SECTION 10 14 23

SECTION 10 14 19 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cast dimensional characters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
- C. Shop Drawings: For dimensional letter signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
- D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

PART 2 - PRODUCTS

2.1 DIMENSIONAL LETTER SIGNS, GENERAL

- A. Regional Materials: Products shall be manufactured within 500 miles (800 km) of Project site.

2.2 DIMENSIONAL CHARACTERS

- A. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Graphics, Inc.
 - b. A. R. K. Ramos Signage Systems.
 - c. ASI Sign Systems, Inc.
 - d. Gemini Incorporated.
 2. Character Material: Cast aluminum.
 3. Character Height: 12 inches.
 4. Thickness: Manufacturer's standard for size of character.
 5. Finishes:
 - a. Integral Aluminum Finish: Clear anodized.
 6. Mounting: Projecting studs.
 7. Font: Times New Roman.
 8. Copy: 4 digit address to be provided by Owner.

2.3 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
1. Use concealed fasteners and anchors unless indicated to be exposed.
 2. For exterior exposure, furnish nonferrous-metal or stainless-steel devices unless otherwise indicated.
 3. Sign Mounting Fasteners:
 - a. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
1. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before

finishing.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- 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.
- C. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
 - 1. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

- a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 19

SECTION 10 14 36 – NON-ILLUMINATED POST AND PANEL SIGNAGE

PART 1 – GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. General Contractor provide and install
 - a. Non-illuminated post and panel signs

1.2 RELATED WORK

A. Specified elsewhere

1. All related exterior improvement work.

1.3 QUALITY ASSURANCE

- A. Company Qualifications: Minimum five (5) years experience in the signage industry.
- B. Install Qualifications: Installers and supervisors trained in the signage industry.
- C. Painting Qualifications: Paint application by a Matthews Paint (PPG) certified applicator or an equal certification from an equal paint manufacturer.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For post and panel signs.
 1. Include fabrication and installation details and attachments to other work.
 2. Show sign mounting heights, locations of supports including foundations and accessories.
 3. Show message list, typestyles, graphic elements, and layout for each sign at least ¼" = 1'-0"
- C. Samples: For each exposed product and for each color and texture specified.
- D. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

1.5 PROTECTION

- A. Contractor is responsible to protect and avoid all existing above ground and underground utilities

during construction operations. Repair of any utilities damaged by construction shall be the responsibility of the Contractor.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to

- a. Deterioration of finishes beyond normal weathering.
- b. Deterioration of embedded graphic image.
- c. Separation or delamination of sheet materials and components.

2. Warranty Period

- a. Five (5) years from date of Substantial Completion.

1.7 FIELD CONDITIONS

A. Existing Signs and Mockup

1. Field verify existing signs and existing mockup for design intent and quality.

PART 2 – PRODUCTS

2.1 SIGN BOARD TYPOGRAPHY

- A. All lettering shall utilize Frutiger 57 Condensed and Frutiger 67 Bold Condensed typeface. Typographic substitutions are not acceptable.
- B. Letter forms and symbols shall be photographically precise, crisp, clean and free of ticks, discontinuous curves, free of line waves, cut or ragged edges, edge build-up, bleeding surface pinholes, and other imperfections. Letterforms shall conform to the prescribed letter form proportions.
- C. Unless otherwise indicated, letterforms shall be aligned to maintain a baseline parallel to the sign format.
- D. All typography shall match intended scaled drawing layouts and approved shop drawings.
- E. Message copy shall be as specified in the Message Schedule as upper and/or lower case type. Alternate letterforms will not be accepted.

2.2 PERFORMANCE REQUIREMENTS

- A. Structure and Anchorage: Engineering for structural integrity and safe permanent installation shall be the sole responsibility of the fabricator/installer and must withstand design loads required by the 2009 International Building Code for this region.
- B. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; material surfaces.

- C. Accessibility Standard: 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 for signs.

2.3 POST AND PANEL SIGNS

- A. Manufacturers: Subject to compliance with requirements:

1. Ace Sign Company, 2540 South First Street, Springfield, IL 62704, 217-522-8417.

- B. Post and Panel Sign: Sign of single-panel with overlay panel configuration; with smooth, uniform surfaces and support assembly; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles.

1. Solid-Sheet Sign Panels, Returns, Back an Overlay panel: Aluminum; 080 thick, custom fabricated sheet with finish specified in "Sign-Panel-Face Finish and Applied Graphics" Subparagraph below and as follows:

a. Surface-Applied Graphics: Applied vinyl film.

2. Posts: Aluminum 0.25 thick.

a. Shape: Round.

b. Size: 4 inch diameter.

c. Installation Method: Direct burial in concrete

d. Finish and Color: MAP – black.

2.4 MATERIALS

- A. Paint and Primer for overlay panel:

1. Mathews Acrylic Polyurethane.

a. Overlay sheet: MAP – MP60698.

2. Shop finish overlay panel.

- B. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive permanent adhesive on back; die cut to form characters or images as indicated and suitable for exterior applications.

1. Letters, Logo and Arrows – 3M 5100-10: Permanent engineer grade retro-reflective film with minimum 7 yr. rated outdoor life.

2. Fin at top of sign – 3M opaque graphic films; light silver metallic #180C-220.

2.5 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.

2. Exposed Metal-Fastener Components for Overlay Panel:

- a. Clear anodized aluminum caps, 5/16" in height x 1" in diameter tapped ¼" deep for 5/16-18 thread stud. The cap includes a side-mounted set screw that can be tightened to prevent unwanted cap removal. Caps will attach to a stud mounted inside 1" diameter x 1" long matching anodized aluminum barrel fastened behind sign panel.

B. Anchoring Materials

1. Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at project site to create pourable anchoring, patching, and grouting compound.
 - a. Water-Resistant Product: At exterior locations, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated. Match existing refurbished exterior signage on campus.
1. Mill joints to tight hairline fit. Form joints exposed to weather to resist water penetration and retention.
 2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
 3. Conceal fasteners and anchors unless indicated to be exposed; locate exposed fasteners where they will be inconspicuous.
 4. Internally brace signs for stability and for securing fasteners.
- B. Post Fabrication: Fabricate posts designed to withstand wind pressure indicated for Project location and of lengths required for installation method indicated for each sign.
1. Aluminum Posts: Manufacturer's standard 0.25-inch thick, extruded-aluminum tubing unless otherwise indicated, with brackets or slots to engage sign panels.
 2. Direct Burial: Fabricate posts 36 inches (910 mm) longer than height of sign to permit embedment in concrete-filled postholes.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General: Install signs using installation methods indicated and according to manufacturer's written instructions.
1. Install signs, level, plumb, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Install signs so they do not protrude or obstruct according to accessibility standard.
 3. Before installation, verify that sign components are clean and free of materials or debris that would impair installation.
 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with

grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING POSTS

A. Direct-Burial Method

1. Excavation: Excavate posthole to dimensions indicated. Reconstruct subgrade that is not firm, undisturbed, or compacted soil, or that is damaged by freezing temperatures, frost, rain, accumulated water, or construction activities by excavating an additional 12 inches (300 mm), backfilling with satisfactory soil or well-graded aggregate, and compacting to original subgrade elevation.
2. Setting in Cast-in-Place Concrete: Set post in position, support to prevent movement, and place concrete in posthole as indicated. Shape top of footing to shed water.

END OF SECTION 10 14 36

SECTION 10 14 37 – EXISTING POST AND PANEL SIGNAGE REFURBISHMENT

PART 1 – GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. General Contractor
 - a. Refurbish existing post and panel signs.

1.2 RELATED WORK

A. Specified elsewhere

1. All related exterior improvement work.

1.3 QUALITY ASSURANCE

- A. Company Qualifications: Minimum five (5) years experience in the signage industry.
- B. Install Qualifications: Installers and supervisors trained in the signage industry.
- C. Painting Qualifications: Paint application by a Matthews Paint (PPG) certified applicator or an equal certification from an equal paint manufacturer.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For post and panel signage.
 1. Include fabrication and installation details and attachments to other work.
 2. Show sign mounting heights, locations of supports including foundations and accessories.
 3. Show message list, tpestyles, graphic elements, and layout for each sign at least ¼" = 1'-0"
- C. Samples: For each exposed product and for each color and texture specified.
- D. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.
 1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Mockup –refurbish 1 sign indicated on the plans for owner review and approval. If approved, mockup will be considered the finished sign for that location.

1.05. PROTECTION

- A. Contractor is responsible to protect and avoid all existing above ground and underground utilities during construction operations. Repair of any utilities damaged by construction shall be the

responsibility of the Contractor.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delaminating of sheet materials and components.
 - 2. Warranty Period
 - a. Five (5) years from date of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Existing Signs & Mockup
 - 1. Field verify existing signs and existing mockup for design intent and quality.

PART 2 – PRODUCTS

2.1 SIGN BOARD TYPOGRAPHY

- A. All lettering shall utilize Frutiger 57 Condensed and Frutiger 67 Bold Condensed typeface. Typographic substitutions are not acceptable.
- B. Letter forms and symbols shall be photographically precise, crisp, clean and free of ticks, discontinuous curves, free of line waves, cut or ragged edges, edge build-up, bleeding surface pinholes, and other imperfections. Letterforms shall conform to the prescribed letter form proportions.
- C. Unless otherwise indicated, letterforms shall be aligned to maintain a baseline parallel to the sign format.
- D. All typography shall match intended scaled drawing layouts and approved shop drawings.
- E. Message copy shall be as specified in the Message Schedule as upper and/or lower case type. Alternate letterforms will not be accepted.

2.2 PERFORMANCE REQUIREMENTS

- A. Structure and Anchorage: Engineering for structural integrity and safe permanent installation shall be the sole responsibility of the fabricator/installer and must withstand design loads required by the 2018 International Building Code for this region.
- B. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; material surfaces.

C. Accessibility Standard: 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 for signs.

2.3 POST AND PANEL SIGNS

A. Manufacturers: Subject to compliance with requirements:

1. Ace Sign Company, 2540 South First Street, Springfield, IL 62704, 217-522-8417.

B. Overlay Panel: Panel configuration; with smooth, uniform surfaces and support assembly; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles.

1. Solid-Sheet Sign Panels, Returns, Back an Overlay panel: Aluminum; 080 thick, custom fabricated sheet with finish specified in "Sign-Panel-Face Finish and Applied Graphics" Subparagraph below and as follows:

a. Surface-Applied Graphics: Applied vinyl film.

2. Posts: Aluminum Steel 0.25 thick.

a. Shape: Round.

b. Size: 4 inch diameter.

c. Installation Method: Direct burial in concrete

d. Finish and Color: MAP – black.

2.4 MATERIALS

A. Paint and Primer:

1. Mathews Acrylic Polyurethane or equal:

a. Sign and base: MAP Black, Satin finish – field spray applied.

1) Use hot weather reducer on surface temperatures over 80 deg.

b. Overlay sheet: MAP – MP60698.

1) Shop applied finish

B. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive permanent adhesive on back; die cut to form characters or images as indicated and suitable for exterior applications.

1. 3M 5100-10: Permanent engineer grade retro-reflective film with minimum 7 yr. rated outdoor life.

C. Solvent Cleaner: Final Clean.

2.5 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
1. Use concealed fasteners and anchors unless indicated to be exposed.
 2. Exposed Metal-Fastener Components for Overlay Panel:
 - a. Clear anodized aluminum caps, 5/16" in height x 1" in diameter tapped ¼" deep for 5/16-18 thread stud. The cap includes a side-mounted set screw that can be tightened to prevent unwanted cap removal. Caps will attach to a stud mounted inside 1" diameter x 1" long matching anodized aluminum barrel fastened behind sign panel.
- B. Anchoring Materials:
1. Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at project site to create pourable anchoring, patching, and grouting compound.
 - a. Water-Resistant Product: At exterior locations, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General: Install signs using installation methods indicated and according to manufacturer's written instructions.
1. Install overlay panels, level, plumb, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Install overlay panels so they do not protrude or obstruct according to accessibility standard.
 3. Before installation, verify that sign components are clean and free of materials or debris that would impair installation.

3.2 INSTALLING POSTS (For relocation of sign)

A. Direct-Burial Method

1. Excavation: Excavate posthole to dimensions indicated. Reconstruct subgrade that is not firm, undisturbed, or compacted soil, or that is damaged by freezing temperatures, frost, rain, accumulated water, or construction activities by excavating an additional 12 inches (300 mm), backfilling with satisfactory soil or well-graded aggregate, and compacting to original subgrade elevation.
2. Setting in Cast-in-Place Concrete: Set post in position, support to prevent movement, and place concrete in posthole as indicated.

END OF SECTION 10 14 37

SECTION 102116.17 - PHENOLIC-CORE SHOWER AND DRESSING 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. Solid, phenolic-core compartments.
- B. Related Requirements:
 - 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for blocking.
 - 2. Section 10 28 00 "Toilet, Bath, and Laundry Accessories" for grab bars, purse shelves, and similar accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For shower and dressing compartments.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Show locations of cutouts for compartment-mounted accessories.
 - 3. Show locations of centerlines of drains.
- C. Samples for Initial Selection: For each type of compartment material indicated.
 - 1. Include Samples of hardware and accessories for material and color selection.
- D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
 - 1. Each type of material, color, and finish required for compartments, prepared on 6-inch- (152-mm-) square Samples of same thickness and material indicated for the Work.
 - 2. Each type of hardware and accessory.
 - 3. Curtain Fabric: 12-inch- (305-mm-) square swatch or larger as required to show complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Door Hinges: One door hinge with associated fasteners.
 - 2. Latch and Keeper: One latch and keeper with associated fasteners.
 - 3. Clothing Hook: One clothing hook with associated fasteners.
 - 4. Door Bumper: One door bumper with associated fasteners.
 - 5. Door Pull: One door pull with associated fasteners.
 - 6. Fasteners: 10 fasteners of each size and type.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of fixtures, drains, walls, columns, ceilings, and other construction contiguous with shower and dressing compartments by field measurements before fabrication.

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. Accessibility Standard: 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 PHENOLIC-CORE COMPARTMENTS

- A. Manufacturers:
 - 1. Accurate Partitions Corporation.
 - 2. Bobrick Washroom Equipment, Inc.
 - 3. General Partitions Mfg. Corp.
 - 4. Knickerbocker Partition Corporation.
 - 5. Equal product if approved by Architect in an addendum.
- B. Toilet-Enclosure Style: Overhead braced.
- C. Urinal-Screen Style: Wall hung.
- D. 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 and no-sightline system. Provide minimum 3/4- inch- (19-mm-) thick doors and pilasters and minimum 1/2-inch- (13-mm-) thick panels.

- E. Pilaster Shoes: Fabricated from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
- F. Brackets (Fittings):
 - 1. Stirrup Type: Ear or U-brackets, chrome-plated brass.
- G. Phenolic-Panel Finish:
 - 1. Facing Sheet Finish: One color and pattern in each room.
 - 2. Color and Pattern: As selected by Architect from manufacturer's full range, with manufacturer's standard dark color core.
- B. Pilaster Shoes, and Sleeves (Caps): Formed from stainless steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.

2.3 MATERIALS

- A. Aluminum Castings: ASTM B26/B26M.
- B. Aluminum Extrusions: ASTM B221 (ASTM B221M).
- C. Brass Castings: ASTM B584.
- D. Brass Extrusions: ASTM B455.
- E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- F. Stainless Steel Castings: ASTM A743/A743M.

2.4 ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
 - 1. Material: Chrome-plated brass.
 - 2. Hinges: Manufacturer's standard paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
 - 3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
 - 4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
 - 5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
 - 6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- A. Overhead Bracing: Manufacturer's standard, continuous, extruded-aluminum headrail or cap with antigrip profile; in manufacturer's standard finish.

- B. Anchorages and Fasteners: Manufacturer's standard, exposed fasteners of stainless steel, chrome-plated steel, or solid brass, finished to match the items they are securing; with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. Use countersunk, flush-type bolt heads or otherwise make fasteners inconspicuous if exposed on opposite side of panel from hardware or accessory item. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.5 FABRICATION

- A. Overhead-Braced Compartments: Manufacturer's standard, corrosion-resistant supports, leveling method, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling method.
- B. Door Sizes and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, inswinging doors for standard shower and dressing compartments, and 36-inch- (914-mm-) wide, outswinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install compartments rigid, straight, level, and plumb. Secure compartments in position with manufacturer's recommended anchoring devices.
- B. Overhead-Braced Compartments: Secure pilasters to floor, and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous headrail 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.

3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION 10 21 16.17

SECTION 10 22 26 - OPERABLE PARTITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Manually operated, single acoustical panel partition.

- B. Related Sections:

- 1. Division 5 Section "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.
 - 2. Division 9 Section "Non-Structural Metal Framing" for sound barrier construction above the ceiling at track and soffit adjacent track.
 - 3. Division 9 Section "Gypsum Board" for sound barrier construction above the ceiling at track and soffit adjacent track.

1.3 DEFINITIONS

- A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."
- B. NIC: Noise Isolation Class.
- C. NRC: Noise Reduction Coefficient.
- D. STC: Sound Transmission Class.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design operable panel partitions, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
 - 1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E 90, determined by ASTM E 413, and rated for not less than the STC indicated.
 - 2. Noise-Reduction Requirements: Operable panel partition assembly, identical to partition tested for STC, tested for sound-absorption performance according to ASTM C 423, and rated for not less than the NRC indicated.
 - 3. Acoustical Performance Requirements: Installed operable panel partition assembly, identical to partition tested for STC, tested for NIC according to ASTM E 336, determined by ASTM E 413, and rated for 10 dB less than STC value indicated.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, numbered panel installation sequence, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data for attachments, signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Indicate storage and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
- C. Samples for Initial Selection: For each type of exposed material, finish, covering, or facing indicated.
 - 1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed material, finish, covering, or facing indicated, prepared on Samples of size indicated below:
 - 1. Textile: Full width by not less than 36-inch- (914-mm-) long section of fabric from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat.
 - 2. Panel Facing Material: Manufacturer's standard-size unit, not less than 3 inches (75 mm) square.
 - 3. Panel Edge Material: Not less than 3 inches (75 mm) long.
 - 4. Hardware: Manufacturer's standard exposed door-operating device.

- E. Delegated-Design Submittal: For operable panel partitions indicated to comply with performance requirements, including analysis data and calculations signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which suspension systems will be attached.
 - 3. Plenum acoustical barriers.
- G. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.
- H. Product Certificates: For each type of operable panel partition, from manufacturer.
- I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each operable panel partition.
- J. Field quality-control reports.
- K. Operation and Maintenance Data: For operable panel partitions to include in maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
 - 2. Seals, hardware, track, carriers, and other operating components.
 - 3. Electric operator.
- L. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- C. Fire-Test-Response Characteristics: Provide panels with finishes meeting one of the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265.

D. Pre-installation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of operable panel partition openings by field measurements before fabrication.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Faulty operation of operable panel partitions.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal wear.
2. Warranty Period: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

- A. Furnish extra materials from the same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Panel Finish-Facing Material: Furnish full width in quantity to cover both sides of two panels when installed.

1.11 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 24 months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operable-partition operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Steel Frame: Steel sheet, manufacturer's standard 0.0508-inch (1.3-mm) nominal minimum thickness for uncoated steel.
- C. Steel Face/Liner Sheets: Tension-leveled steel sheet, manufacturer's standard minimum 0.0299-inch (0.75-mm) nominal minimum thickness for uncoated steel.
- D. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; ASTM B 221 (ASTM B 221M) for extrusions; manufacturer's standard strengths and thicknesses for type of use.
 - 1. Frame Reinforcement: Manufacturer's standard steel or aluminum.

2.2 OPERABLE ACOUSTICAL PANELS

- A. Operable Acoustical Panels: Operable acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. FolDoor; Holcomb & Hoke Mfg. Co., Inc.
 - b. Hufcor.
 - c. Modernfold, Inc.; a DORMA Group Company.
 - d. Panelfold Inc.
 - e. Equal product approved by Architect in an addendum.
- B. Panel Operation: Manually operated, individual panels.
- C. Panel Construction: Provide top reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
- D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
 - 1. Panel Width: Standard widths.
- E. STC: Not less than 50.

- F. Panel Weight: 12 lb/sq. ft. (59 kg/sq. m) maximum.
- G. Panel Thickness: Not less than 3 inches (75 mm).
- H. Panel Closure: Manufacturer's standard.
 - 1. Initial Closure: Flexible, resilient PVC, bulb-shaped acoustical seal.
 - 2. Final Closure: Constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal.
- I. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.

2.3 SEALS

- A. General: Provide types of seals indicated that produce operable panel partitions complying with acoustical performance requirements and the following:
 - 1. Manufacturer's standard seals.
 - 2. Seals made from materials and in profiles that minimize sound leakage.
 - 3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.
- B. Vertical Seals: Deep-nesting, interlocking astragals mounted on each edge of panel, with continuous PVC acoustical seal.
- C. Horizontal Top Seals:
 - 1. Continuous-contact, extruded-PVC seal exerting uniform constant pressure on track.
- D. Horizontal Bottom Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.
 - 1. Mechanically Operated for Acoustical Panels: Extension and retraction of bottom seal by operating handle or built-in operating mechanism, with operating range not less than 1-1/2 inches (38 mm) between retracted seal and floor finish.

2.4 FINISH FACING

- A. General: Provide finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant non-staining adhesive as recommended by facing manufacturer's written instructions.
 - 1. Apply one-piece, seamless facings free of air bubbles, wrinkles, blisters, and other defects, with no gaps or overlaps. Horizontal seams are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
 - 2. Where facings with directional or repeating patterns or directional weave are indicated, mark facing top and attach facing in same direction.
 - 3. Match facing pattern 72 inches (1830 mm) above finished floor.

4. Color/Pattern: DesignTex; Empanada, 4204 – 102 Otono.
- B. Fabric Wall Covering: 100 percent Ingeo (PLA), from same dye lot, treated to resist stains.
- C. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.5 SUSPENSION SYSTEMS

- A. Suspension Tracks: Steel or aluminum with adjustable steel hanger rods for overhead support, designed for type of operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch (2.54 mm) between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
 1. Panel Guide: Aluminum; finished with factory-applied, decorative, protective finish.
 2. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.
- B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.
 1. Multidirectional Carriers: Capable of negotiating 90-degree L, T, and X intersections without track switches.
- C. Track Intersections, Switches, and Accessories: As required for type of operation, storage, track configuration, and layout indicated for operable panel partitions, and compatible with partition assembly specified. Fabricate track intersections and switches from steel or aluminum.
 1. Curve-and-Diverter Switches: Allowing radius turns to divert panels to an auxiliary track.
 2. L Intersections: Allowing panels to change 90 degrees in direction of travel.
- D. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with ASTM E 557 except as otherwise required by operable panel partition manufacturer's written installation instructions.
- B. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed.
- C. Install panels from marked packages in numbered sequence indicated on Shop Drawings.
- D. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.
- E. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

3.3 ADJUSTING

- A. Adjust operable panel partitions to operate smoothly, without warping or binding. Lubricate hardware and other moving parts.
- B. Adjust panels to operate smoothly and easily, without binding or warping. Check and readjust operating hardware. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.4 CLEANING

- A. Clean soiled surfaces of operable panel partitions to remove dust, loose fibers, fingerprints, adhesives, and other foreign materials according to manufacturer's written instructions.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

END OF SECTION 10 22 26

SECTION 10 22 39 - FOLDING PANEL PARTITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Manually operated, acoustical panel partitions.

- B. Related Requirements:

- 1. Section 05 50 00 "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.
 - 2. Section 09 29 00 "Gypsum Board" for fire-rated assemblies and sound barrier construction above the ceiling at track.

1.3 DEFINITIONS

- A. NIC: Noise Isolation Class.
- B. NRC: Noise Reduction Coefficient.
- C. STC: Sound Transmission Class.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For operable panel partitions.
 - 1. Include plans, elevations, sections, attachment details, and numbered panel installation sequence.
 - 2. Indicate stacking and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
 - 3. Include diagrams for power, signal, and control wiring.

- C. Samples for Initial Selection: For each type of exposed material, finish, covering, or facing.
 - 1. Include Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed material, finish, covering, or facing, prepared on Samples of size indicated below:
 - 1. Textile Facing Material: Full width by not less than 36-inch- (914-mm-) long section of fabric, if shown from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat.
 - 2. Panel Facing Material: Manufacturer's standard-size unit, not less than 3 inches (75 mm) square.
 - 3. Panel Edge Material: Not less than 3 inches (75 mm) long.
 - 4. Hardware: One of each exposed door-operating device, if shown.
- E. Delegated-Design Submittal: For operable panel partitions.
 - 1. Include design calculations for seismic restraints that brace tracks to structure above.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Partition track, track supports and bracing, switches, turning space, and storage layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which suspension systems will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. HVAC ductwork, outlets, and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Smoke detectors.
 - f. Access panels.
- B. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.
- C. Seismic Qualification Certificates: For operable panel partitions, tracks, accessories, and components, from manufacturer. Include seismic capacity of partition assemblies to remain in vertical position during a seismic event and the following:
 - 1. Basis for Certification: Indicate whether certification is based on analysis, testing, or experience data, according to ASCE/SEI 7.
 - 2. Detailed description of partition anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of operable panel partition.

1. Include approval letter signed by manufacturer acknowledging Owner-furnished panel facing material complies with requirements.
- E. Product Test Reports: For each operable panel partition, for tests performed by a qualified testing agency.
- F. Field quality-control reports.
- G. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For operable panel partitions to include in maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
 - b. Seals, hardware, track, track switches, carriers, and other operating components.
 - c. Electric operator and controls.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Panel Finish-Facing Material: Furnish full width in quantity to cover both sides of two panels when installed.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Faulty operation of operable panel partitions.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic bracing of tracks to structure above.
- B. Seismic Performance: Operable panel partitions shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the partition panels will remain in place without separation of any parts when subjected to the seismic forces specified."
- C. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
 1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E90, determined by ASTM E413, and rated for not less than the STC indicated.
 2. Noise-Reduction Requirements: Operable panel partition assembly, identical to partition tested for STC, tested for sound-absorption performance according to ASTM C423, and rated for not less than the NRC indicated.
 3. Noise-Isolation Requirements: Installed operable panel partition assembly, identical to partition tested for STC, tested for NIC according to ASTM E336, determined by ASTM E413, and rated for 10 dB less than STC value indicated.
- D. Fire-Test-Response Characteristics: Provide panels with finishes complying with one of the following as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:
 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 2. Fire Growth Contribution: Complying with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.
- E. Fire Resistance: Provide fire-rated operable panel partition assemblies including pass doors, if shown complying with NFPA 80, based on testing according to UL 10B for fire-rated door assemblies.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 2. Pass doors in fire-rated operable panel partition assemblies shall meet positive-pressure requirements.
- 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.

2.2 OPERABLE ACOUSTICAL PANELS

- A. Operable Acoustical Panels: Operable acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. FolDoor; Holcomb & Hoke Mfg. Co., Inc.
 - b. Hufcor.
 - c. Modernfold, Inc.; a DORMA Group Company.
 - d. Panelfold Inc.
 - e. Equal product approved by Architect in an addendum.
- B. Panel Operation: Manually operated, individual panels.
- C. Panel Construction: Provide top reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
- D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
1. Panel Width: Standard widths.
- E. STC: Not less than 50.
- F. Panel Weight: 12 lb/sq. ft. (59 kg/sq. m) maximum.
- G. Panel Thickness: Not less than 3 inches (75 mm).
- H. Panel Closure: Manufacturer's standard.
1. Initial Closure: Flexible, resilient PVC, bulb-shaped acoustical seal.
 2. Final Closure: Constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal.
- I. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.

2.3 SEALS

- A. Description: Seals that produce operable panel partitions complying with performance requirements and the following:
 - 1. Manufacturer's standard seals unless otherwise indicated.
 - 2. Seals made from materials and in profiles that minimize sound leakage.
 - 3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.
- B. Vertical Seals: Deep-nesting, interlocking astragals mounted on each edge of panel, with continuous, resilient acoustical seal.
- C. Horizontal Top Seals: Continuous-contact, resilient seal exerting uniform constant pressure on track.
- D. Horizontal Bottom Seals: Resilient, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.
 - 1. Mechanically Operated for Acoustical Panels: Extension and retraction of bottom seal by operating handle or built-in operating mechanism, with operating range not less than 1-1/2 inches (38 mm) between retracted seal and floor finish.

2.4 PANEL FINISH FACINGS

- A. Description: Finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.
 - 1. Apply one-piece, seamless facings free of air bubbles, wrinkles, blisters, and other defects, with no gaps or overlaps. Horizontal butted edges are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
 - 2. Where facings with directional or repeating patterns or directional weave are indicated, mark facing top and attach facing in same direction.
 - 3. Match facing pattern 72 inches (1830 mm) above finished floor.
- B. Fabric Wall Covering: 100 percent polyolefin woven fabric, from same dye lot, treated to resist stains.
 - 1. Color/Pattern: Match Architect's samples.

2.5 SUSPENSION SYSTEMS

- A. Tracks: Steel or aluminum with adjustable steel hanger rods for overhead support, designed for operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch (2.54 mm) between

bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.

1. Panel Guide: Aluminum guide on both sides of the track to facilitate straightening of the panels; finished with factory-applied, decorative, protective finish.
 2. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.
- B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.
1. Multidirectional Carriers: Capable of negotiating intersections without track switches.
- C. Track Intersections, Switches, and Accessories: As required for operation, storage, track configuration, and layout indicated for operable panel partitions, and compatible with partition assembly specified. Fabricate track intersections and switches from steel or aluminum.
1. Curve-and-Diverter Switches: Allow radius turns to divert panels to an auxiliary track.
 2. L Intersections: Allow panels to change 90 degrees in direction of travel.
- D. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine flooring, floor levelness, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed in area of partition installation.
- B. Install panels in numbered sequence indicated on Shop Drawings.
- C. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.
- D. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.
- E. Light-Leakage Test: Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids. Adjust partitions for alignment and full closure of vertical joints and full closure along top and bottom seals. Perform test and make adjustments before NIC testing.

3.3 FIELD QUALITY CONTROL

- A. NIC Testing: Engage a qualified testing agency to perform tests and inspections.
 - 1. Testing Extent: Testing agency shall randomly select one operable panel partition installation(s) for testing.
 - 2. Testing Methodology: Perform testing of installed operable panel partition for noise isolation according to ASTM E336, determined by ASTM E413, and rated for not less than NIC indicated. Adjust and fit partitions to comply with NIC test method requirements.
- B. An operable panel partition installation will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust operable panel partitions, hardware, and other moving parts to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust storage pocket doors if any, to operate smoothly and easily, without binding or warping.
- C. Verify that safety devices are properly functioning.

3.5 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operable-partition operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

END OF SECTION 10 22 39

SECTION 10 26 00 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Corner guards.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For each type of wall and door protection showing locations and extent.
 - 1. Include plans, elevations, sections, and attachment details.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.
 - 1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

2.2 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.

2.3 CORNER GUARDS

- A. Surface-Mounted, Plastic-Cover Corner Guards: Manufacturer's standard, assembly consisting of snap-on, resilient plastic cover installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Activar Construction Products Group, Inc.
 - b. Babcock-Davis.
 - c. Construction Specialties, Inc.
 - d. InPro Corporation (IPC).
 - e. Korogard Wall Protection Systems; a division of RJF International Corporation.
 - f. Equal product if approved by Architect in an addendum.
 2. Wing Size: Nominal 1-1/8 by 1-1/8 inches (30 by 30 mm).
 3. Height: 4 feet (1.2 m).
 4. Mounting: Adhesive.
 5. Color and Texture: Multiple colors as selected by Architect from manufacturer's full range.

2.4 MATERIALS

- A. Plastic Materials: Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.
- B. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- C. Adhesive: As recommended by protection product manufacturer.

2.5 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.6 FINISHES

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of the Work.
- B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall and door protection 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 wall and door protection in locations and at mounting heights indicated on Drawings.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10 26 00

SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY 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. Public-use washroom accessories.
2. Childcare accessories.
3. Custodial accessories.
4. Warm-air dryers.

B. Related Requirements:

1. Section 088300 "Mirrors" for frameless mirrors.
2. Section 093013 "Tiling" for ceramic toilet and bath accessories, if any.

1.3 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Include electrical characteristics.

B. Samples: Full size, for each exposed product and for each finish specified.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.7 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, visible silver spoilage defects.
 2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Basis-of-Design Product: The design for accessories is based on products indicated. Subject to compliance with requirements, provide the named product or a comparable product by one of the following, except where indicated otherwise:
1. American Specialties, Inc.
 2. Bobrick Washroom Equipment, Inc.
 3. Royce Rolls Ringer Company.
- B. Grab Bar:
1. Basis-of-Design Product: American Specialties 3800 Series
 2. Mounting: Flanges with concealed fasteners.
 3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.
 4. Outside Diameter: 1-1/2 inches (38 mm).
 5. Configuration and Length: As indicated on Drawings.

C. Robe Hook:

1. Basis-of-Design Product: American Specialties 0714.
2. Description: Single-prong unit with bumper.
3. Material and Finish: Stainless steel, No. 4 finish (satin).

D. Shelf:

1. Basis-of-Design Product: American Specialties 0692 Series.
2. Description: Shelf with support brackets.
3. Nominal Size: 18 inches (457 mm) long by 6 inches (152 mm) wide.
4. Material and Finish: Stainless steel, No. 4 finish (satin).

E. Combination Convertible Towel Dispenser/Waste Receptacle:

1. Basis-of-Design Product: Bobrick B-39617 less paper towel dispenser.
2. Description: Convertible combination unit for interchangeable types of paper towel dispensers and sizes of removable waste receptacles. Provide unit without paper towel dispenser.
3. Mounting: Semirecessed.
 - a. Designed for nominal 4-inch (100-mm) wall depth.
4. Minimum Waste Receptacle Capacity: 18 gal. (68.0 L).
5. Material and Finish: Stainless steel, No. 4 finish (satin).
6. Liner: Reusable, vinyl waste-receptacle liner.
7. Lockset: Tumbler type for towel dispenser compartment and wastereceptacle.

F. Toilet Tissue (Roll) Dispenser:

1. Product: Provide Royce Rolls Ringer Company; Stainless Steel Toilet Paper Dispenser, Standard Model TP-4
2. Description: Multi-roll dispenser with pad lock.
3. Mounting: Surface mounted.
4. Operation: Noncontrol delivery with standard tube.
5. Material and Finish: Stainless steel, No. 4 finish (satin).
6. Locks: Manufacturer's pad locks at each end of tube.

G. Paper Towel (Roll) Dispenser:

1. Product: Provide Georgia-Pacific 54338. No substitution.
2. Description: Lever-actuated mechanism permitting controlled delivery of paper rolls in preset lengths per stroke.
3. Mounting: Surface mounted.
4. Capacity: High capacity 8-inch- (203-mm-) diameter roll.
5. Material and Finish: Manufacturer's standard.
6. Lockset: Manufacturer's standard.

H. Liquid-Soap Dispenser:

1. Product: Provide Uline H-3476 Bulk Soap Wall-mount Dispenser.
2. Description: Designed for dispensing soap in foam form.

3. Mounting: Vertically oriented, surface mounted.
4. Capacity: 46 oz.
5. Materials: Manufacturer's standard.
6. Lockset: Manufacturer's standard.

2.2 CHILDCARE ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated below or comparable product by one of the following:
1. American Specialties, Inc.
 2. Brocar Products, Inc.
 3. Koala Kare Products; a division of Bobrick Washroom Equipment, Inc.
- B. Diaper-Changing Station:
1. Basis-of-Design Product: American Specialties 9013.
 2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
 - a. Engineered to support a minimum of 200-lb (90-kg) static load when opened.
 3. Mounting: Recess mounted.
 4. Operation: By pneumatic shock-absorbing mechanism.
 5. Material and Finish: Stainless steel, No. 4 finish (satin), with replaceable insulated polystyrene tray liner and rounded plastic corners.
 6. Liner Dispenser: Built in.

2.3 CUSTODIAL ACCESSORIES

- A. Basis-of-Design Product: The design for accessories is based on products indicated. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
1. American Specialties, Inc.
 2. Bobrick Washroom Equipment, Inc.
 3. Royce Rolls Ringer Company.
- B. Utility Shelf:
1. Basis-of-Design Product: American Specialties 1315.
 2. Description: Surface mounted shelf with brackets and mop/broom holders.
 3. Length: 36 inches.
 4. Hooks: Three.
 5. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
 6. Material and Finish: Stainless steel, No. 4 finish (satin).

2.4 WARM-AIR DRYERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated below or comparable product by one of the following:

1. American Specialties, Inc.
2. Dyson.

B. Warm-Air Dryer:

1. Basis-of-Design Product: American Specialties; TRI-Umph 20200.
2. Mounting: Surface mounted.
3. Operation: Electronic-sensor activated with timed power cut-off switch.
4. Volume: Minimum 74 cfm
 - a. Operation Time: 20 seconds.
5. Cover Material and Finish: Molded plastic, gray.
6. Electrical Requirements: As indicated on the Electrical Drawings.

2.3 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.

B. Utility Shelf .

1. Description: With exposed edges turned down not less than 1/2 inch (13 mm) and supported by two triangular brackets welded to shelf underside.
2. Size: 16 inches (406 mm) long by 6 inches (152 mm) deep.
3. Material and Finish: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel, ASTM A480/A480M No. 4 finish (satin).

C. Mop and Broom Holder:

1. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf .
2. Length: 36 inches (914 mm).
3. Hooks: Four.
4. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
 - b. Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.

2.4 MATERIALS

- A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.
- C. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 (Z180) hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- G. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).
- H. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.5 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 10 28 00

SECTION 10 44 13 - FIRE PROTECTION CABINETS

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. Fire-protection cabinets for the following:
 - a. Portable fire extinguisher.

B. Related Requirements:

- 1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets

1.3 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

- 1. Review methods and procedures related to fire-protection cabinets, including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
- 2. Show location of knockouts for hose valves.

B. Shop Drawings: For fire-protection cabinets.

- 1. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Samples for Initial Selection: For each type of exposed finish required.

- E. Samples for Verification: For each type of exposed finish required, prepared on samples 6 by 6 inches (150 by 150 mm) square.
- F. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.
- 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.

2.3 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. J. L. Industries, Inc., a division of Activar Construction Products Group; Academy Series.
 - b. Larsen's Manufacturing Company; Architectural Series.
 - c. Potter Roemer Fire Pro; 1700 Series.
 - d. Equal product approved by Architect in an addendum.
- B. Cabinet Construction: Nonrated in nonrated wall, rated in rated wall (same rating as wall).

1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- (1.09-mm-) thick cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: Cold-rolled steel sheet or Stainless steel sheet – see drawings.
1. Shelf: Same metal and finish as cabinet.
- D. Recessed Cabinet (see drawings for recessed, semi-recessed, or surface mounted):
1. Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box, to act as drywall bead.
 2. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.
 3. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
- E. Semirecessed Cabinet (see drawings for recessed, semi-recessed, or surface mounted): One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
1. Square-Edge Trim: 1-1/4- to 1-1/2-inch (32- to 38-mm) backbend depth.
- F. Surface-Mounted Cabinet (see drawings for recessed, semi-recessed, or surface mounted): Cabinet box fully exposed and mounted directly on wall with no trim.
- G. Cabinet Trim, Door Material: Steel sheet or Stainless steel sheet. Same material and finish as door.
- H. Door Style: Solid opaque panel with frame.
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
1. Provide projecting door pull and friction latch.
 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- J. Accessories:
1. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet door.
 - 2) Application Process: Etched.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.

2.4 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
 - 2. Miter corners and grind smooth.
 - 3. Provide factory-drilled mounting holes.
 - 4. Prepare doors and frames to receive locks.
 - 5. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
 - 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
 - 2. Fabricate door frames of one-piece construction with edges flanged.
 - 3. Miter and weld perimeter door frames and grind smooth.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for recessed and semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at height indicated below:
 - 1. Fire-Protection Cabinets: 42 inches (1067 mm) above finished floor to top of fire extinguisher.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
 - 2. Provide inside latch and lock for break-glass panels.
 - 3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
 - 4. Fire-Rated Cabinets:
 - a. Install cabinet with not more than 1/16-inch (1.6-mm) tolerance between pipe OD and knockout OD. Center pipe within knockout.
 - b. Seal through penetrations with firestopping sealant as specified in Section 078413 "Penetration Firestopping."

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 13

SECTION 10 44 16 - FIRE EXTINGUISHERS

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 portable, hand-carried fire extinguishers.
- B. Related Requirements:
 - 1. Section 10 44 13 "Fire Protection Cabinets."

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
 - b. Faulty operation of valves or release levers.
2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

2.2 FIRE EXTINGUISHERS

- A. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 1. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) JL Industries, Inc.; a division of the Activar Construction Products Group.
 - 2) Kidde Residential and Commercial Division.
 - 3) Larsens Manufacturing Company.
 - 4) MOON American.
 - 5) Potter Roemer LLC.
 2. Valves: Manufacturer's standard.
 3. Handles and Levers: Manufacturer's standard.
 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
 - B. Multipurpose Dry-Chemical Type: UL-rated 4-A:60-B:C, 10-lb (4.5-kg) nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 10 44 16

SECTION 10 51 13 - METAL LOCKERS

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. Knocked-down lockers.
 - 2. Locker benches.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.
- B. Shop Drawings: For metal lockers.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Show locker trim and accessories.
 - 3. Include locker identification system and numbering sequence.
- C. Samples: For each color specified, in manufacturer's standard size.
- D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available.
- E. Samples for Verification: For the following products, in manufacturer's standard size:
 - 1. Lockers and equipment.
 - 2. Locker benches.
- F. Product Schedule: For lockers.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. The following metal locker hardware items equal to 10 percent of amount installed for each type and finish installed, but no fewer than five units:
 - a. Blank identification plates.
 - b. Hooks.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.10 COORDINATION

- A. Coordinate sizes and locations of bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of latches and other door hardware.

2. Damage from deliberate destruction and vandalism is excluded.
3. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain metal lockers, locker benches, and accessories from single source from single locker manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design", the ABA standards of the Federal agency having jurisdiction, and ICC A117.1.

2.3 KNOCKED-DOWN CORRIDOR LOCKERS

- A. Manufacturers:
 1. Lyon Workspace Products; Standard Lockers.
 2. Penco Products, Inc., Subsidiary of Vesper Corporation; Guardian Lockers.
 3. Republic Storage Systems Company; Quiet Lockers.
 4. Equal products if approved by Architect in an addendum.
- B. Doors: One piece; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
 1. Doors less than 12 inches (305 mm) wide may be fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
 2. Doors for box lockers less than 15 inches (381 mm) wide may be fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
 3. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.
 4. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet; welded to inner face of doors.
 5. Sound-Dampening Panels: Manufacturer's standard, designed to stiffen doors and reduce sound levels when doors are closed, of die-formed metal with full perimeter flange and sound-dampening material; welded to inner face of doors.
 6. Door Style: Vented panel as follows:
 - a. Louvered Vents: No fewer than six louver openings at top and bottom for single-tier.
- C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
 1. Tops, Bottoms, and Intermediate Dividers: 0.024-inch (0.61-mm) nominal thickness, with single bend at sides.

2. Backs and Sides: 0.024-inch (0.61-mm) nominal thickness, with full-height, double-flanged connections.
 3. Shelves: 0.024-inch (0.61-mm) nominal thickness, with double bend at front and single bend at sides and back.
- D. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.
1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
 2. Frame Vents: Fabricate face frames with vents.
- E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees; self-closing.
1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches (51 mm) high. Provide no fewer than three hinges for each door more than 42 inches (1067 mm) high.
 2. Continuous Hinges: Manufacturer's standard, steel, full height.
 3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.
- F. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.
1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and prelocking.
 - a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
 - b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
 - c. Latch Hook: Equip each door with one latch hook, fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.
- G. Locks: Combination padlocks.
- H. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch (9 mm) high.
- I. Hooks: Manufacturer's standard ball-pointed hooks, aluminum or steel; zinc plated.
- J. Coat Rods: Manufacturer's standard.
- K. Coat Rods: 3/4-inch- (19-mm-) diameter steel tube or rod, chrome finished.
- L. Continuous Zee Base: Fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet.

1. Height: 4 inches (102 mm).
- M. Continuous Sloping Tops: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm) nominal-thickness steel sheet.
1. Closures: Vertical or Hipped-end type.
 2. Sloping-top corner fillers, mitered.
- N. Individual Sloping Tops: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet.
- O. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
- P. Filler Panels: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch (0.91-mm) nominal-thickness steel sheet.
- Q. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
- R. Center Dividers: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet.
- S. Materials:
1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
- T. Finish: Baked enamel or powder coat.
1. Color: As selected by Architect from manufacturer's full range.
- 2.4 LOCKS
- A. Combination Padlock: Not provided by Owner.
- 2.5 LOCKER BENCHES
- A. Provide bench units with overall assembly height of 17-1/2 inches (445 mm).
- B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick (241 mm wide by 32 mm thick).
 2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
- C. Fixed-Bench Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:
1. Tubular Steel: 1-1/2-inch- (38-mm-) diameter steel tubing threaded on both ends, with standard pipe flange at top and bell-shaped cast-iron base; with baked-enamel or powder-coat finish; anchored with exposed fasteners.
 - a. Color: As selected by Architect from manufacturer's full range.

2.6 FABRICATION

- A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
 - 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
 - 2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
- B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.
- C. Equipment: Provide each locker with an identification plate and the following equipment:
 - 1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
 - 2. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
 - 3. Triple-Tier Units: One double-prong ceiling hook.
 - 4. Coat Rods: In lieu of ceiling hook for metal lockers 24 inches (610 mm) high or more.
- D. Knocked-Down Construction: Fabricate metal lockers by preassembling at plant prior to shipping, using manufacturer's nuts, bolts, screws, or rivets.
- E. Accessible Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches (381 mm) above the floor.
 - 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above the floor.
- F. Continuous Zee Base: Fabricated in lengths as long as practical to enclose base and base ends; finished to match lockers.
- G. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
 - 1. Sloping-top corner fillers, mitered.
- H. Individual Sloping Tops: Fabricated in width to fit one locker frame in lieu of flat locker tops; with integral back; finished to match lockers. Provide wedge-shaped divider panels between lockers.
- I. Recess Trim: Fabricated with minimum 2-1/2-inch (64-mm) face width and in lengths as long as practical; finished to match lockers.
- J. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
- K. Finished End Panels: Fabricated to conceal unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
 - 1. Provide one-piece panels for double-row (back-to-back) locker ends.
- L. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

2.7 ACCESSORIES

- A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
- B. Anchors: Material, type, and size required for secure anchorage to each substrate.
 - 1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls, and elsewhere as indicated, for corrosion resistance.
 - 2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lockers level, plumb, and true; shim as required, using concealed shims.
 - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
 - 2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
 - 3. Anchor back-to-back metal lockers to floor.
- B. Knocked-Down Lockers: Assemble with manufacturer's standard fasteners, with no exposed fasteners on door faces or face frames.
- C. Equipment:
 - 1. Attach hooks with at least two fasteners.
 - 2. Identification Plates: Identify metal lockers with identification indicated on Drawings.
 - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
- D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach recess trim to recessed metal lockers with concealed clips.
 - 2. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
 - 3. Attach sloping-top units to metal lockers, with closures at exposed ends.

- E. Fixed Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches (1830 mm) apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.

3.3 ADJUSTING

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.

3.4 PROTECTION

- A. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- B. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10 51 13

SECTION 10 80 03 – KNOX BOX

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. KNOX Box.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include identification sequence for compartments.
 - 2. Include layout of identification text.
 - 3. Include setting drawings, templates, and installation instructions for anchor bolts and other anchorages installed as part of the work of other Sections.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate layout and installation with wall construction.
- B. Templates: Obtain templates for installing box.

PART 2 - PRODUCTS

2.1 KNOX BOX

Surface or recessed mount with hinged door, with UL Listed tamper switches.
1/4" plate steel housing, 1/2" thick steel door with interior gasket seal and stainless steel door hinge. Box and lock UL Listed. Lock has 1/8" thick stainless steel dust cover with tamper seal mounting capability.
Exterior Dimensions: Surface mount body - 4"H x 5"W x 3-3/4"D
Recessed mount flange - 7"H x 7"W

Lock:	UL Listed. Double-action rotating tumblers and hardened steel pins accessed by a biased cut key.
Finish:	Knox-Coat® proprietary finishing process
Colors:	Black, Dark Bronze or Aluminum – Architect to select color.
P/N:	3200 Series KNOX-BOX (mfr's cat. ID)
Mfr's Name:	KNOX COMPANY

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for roughing-in openings, clearances, and other conditions affecting performance of the Work.
- B. Examine walls and other adjacent construction for suitable conditions where units will be installed.
- C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install level and plumb, according to manufacturer's written instructions and roughing-in drawings.
 - 1. Where dissimilar metals will be in permanent contact with each other, protect against galvanic action by painting contact surfaces with bituminous coating or by applying other permanent separation as recommended by manufacturer for this purpose.

3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Remove temporary protective coverings and strippable films.
- B. Adjust doors, hardware, and moving parts to function smoothly.
- C. Touch up marred finishes or replace BOX that cannot be restored to factory-finished appearance.

END OF SECTION 10 80 03

SECTION 11 13 19 - STATIONARY LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Stationary loading dock lifts (scissor lifts).

1.3 DEFINITIONS

- A. Operating Range: Maximum amount of travel above and below the loading dock level.
- B. Working Range: Recommended amount of travel above and below the loading dock level for which loading and unloading operations can take place.

1.4 COORDINATION

- A. Coordinate size and location of loading dock equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation
- B. Coordinate installation of cast-in-place items. Furnish setting drawings and templates.
- C. Electrical System Roughing-in: Coordinate layout and installation of loading dock equipment with connections to power supplies and interlocked equipment.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
 - 2. Review sequence of operation for each type of loading dock equipment.
 - 3. Review coordination of interlocked equipment specified in this Section and elsewhere.
 - 4. Review required testing, inspecting, and certifying procedures.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for stationary loading dock equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For stationary loading dock equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of anchors and each field connection.
3. Include diagrams for power, signal, and control wiring.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Product Test Reports: For each dock leveler, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Indicate compliance of dock levelers with requirements in MH 30.1 for determining rated capacity based on comprehensive testing within last two years of current products.
2. Submittal Form: According to MH 30.1.

D. Sample Warranty: For manufacturer's special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For stationary loading dock equipment to include in operation and maintenance manuals.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. 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."

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace dock levelers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Structural failures including cracked or broken structural support members, load-bearing welds, and front and rear hinges.
 - b. Faulty operation of operators, control system, or hardware.
 - c. Deck plate failures including cracked plate or permanent deformation in excess of 1/4 inch (6 mm) between deck supports.
 - d. Hydraulic system failures including failure of hydraulic seals and cylinders.
2. Warranty Period for Structural Assembly: 10 years from date of Substantial Completion.
 3. Warranty Period for Hydraulic System: Four years from date of Substantial Completion.
 4. Warranty shall be for unlimited usage of leveler for the specified rated capacity over the term of the warranty.

PART 2 - PRODUCTS

2.1 STATIONARY LOADING DOCK LIFTS

- A. General: Stationary, scissors-type, single-leg, hydraulic dock lift of capacity, size, and construction indicated; complete with controls, safety devices, and accessories required.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Blue Giant Equipment Corporation; LoMaster Series Model ED Stationary Hydraulic or a comparable product by one of the following:
 - a. Advance Lifts, Inc.
 - b. Autoquip Corporation.
 - c. Beacon Industries, Inc.
 - d. Kelley; 4Front Engineered Solutions, Inc.
 - e. Pentalift Equipment Corporation.
 - f. Vestil Manufacturing Company.
- 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. Standard: MH 29.1.
- D. Rated Capacity: Lifting capacity of not less than 8000 lb (3629) kg).
- E. Platform: Nonskid, safety-tread steel deck plate.
 1. Platform Size: 96 inches (2438 mm) long by 72 inches (1829 mm) wide.
 2. Platform Guarding: Bevel toe guards to comply with requirements in MH 29.1.
 3. Removable Guard Rails: Provide aluminum guard rails on two sides of platform with a single, removable chain across each end. Provide guard rails not less than 39 inches (991 mm) high with midrail and 4-inch- (102-mm-) high, kick plate at bottom. Mount rail sockets flush with platform surface.
- F. Bridge: Nonskid, safety-tread, hot-dip galvanized-steel plate.
 1. Hinged Bridge: Hinged, throw-over bridge bolted to full-length, heavy-duty, piano-type hinge welded to toe guard at end of platform. Provide bridge complete with heavy-duty lifting chains. Chamfer edge of bridge to minimize obstructing wheels of material-handling vehicles.

2. Size: 30 inches by 60 inches.
 3. Locations: As indicated on Drawings.
- G. Function: Dock lifts shall compensate for differences in height between truck bed and loading platform.
1. Vertical Travel and Travel Speed: As indicated on Drawings.
 2. Vertical Travel: Maximum of 60 (1524) inches (mm).
 3. Travel Speed: Nominal raising speed of 10 (0.05)fpm (m/s).
 4. Hinged Throw-over Bridge Operation: Manual-assist bridge winch.
- H. Hydraulic Operating System: Self-contained, electric, hydraulic power unit for raising and lowering lift; of size, type, and operation needed for capacity of lift indicated; controlled from a remotely located push-button station.
1. Power Unit: Consisting of continuous-duty motor, high-pressure gear pump, valve manifold, oil-line filters, and oil reservoir.
 - a. Equip manifold with relief valve, check valve, pressure-compensated flow-control valve, and solenoid valve and with provisions for lowering lift manually if power fails.
 - b. Equip reservoir, valve manifold, and pressure line with oil-line filters.
 2. Cylinders: Equip lift with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement-plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.
 - a. Rate of Descent Protection: Pressure-compensated flow control or hydraulic velocity fuse to limit down speed for each cylinder.
 3. Remote-Control Station: Multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, Type 12 box.
 - a. Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.
- I. Construction: Fabricate lift from structural-steel shapes rigidly welded and reinforced for maximum strength, safety, and stability. Design assembly to withstand deformation during both operating and stored phases of service. Provide mounting brackets and removable lifting eyes for ease of installation.
1. Scissors Mechanism: Fabricate leg members from heavy, hot-dip galvanized- steel-formed tube or plate members to provide maximum strength and rigidity.
 2. Bearings: Pivot points with permanently lubricated antifriction bushings or sealed ball-bearings for minimum maintenance.
 3. Maintenance Leg: Removable, safety maintenance leg or hinged, safety maintenance bars.
 4. Mounting: As indicated.
- J. Materials:
1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade 55 (380).
3. Steel Tubing: ASTM A500/A500M, cold formed.

K. Dock Lift Finish: Manufacturer's standard baked-on factory finish unless otherwise indicated.

2.2 FINISH REQUIREMENTS

A. Hot-Dip Galvanizing: Comply with the following:

1. ASTM A123/A123M for iron and steel loading dock equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical systems for loading dock equipment to verify actual locations of connections before equipment installation.
- C. Examine walls and floors of pits for suitable conditions where recessed loading dock equipment is to be installed. Pits shall be plumb and square and properly sloped for drainage from back to front of loading dock.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Set curb angles in concrete edges of dock-leveler recessed pits with tops flush with loading platform. Fit exposed connections together to form hairline joints.
- B. Set curb angles in concrete edges of truck-leveler recessed pits with tops flush with driveway. Fit exposed connections together to form hairline joints.
- C. Place self-forming pan system for recessed dock or edge-of-dock (see drawings) levelers in proper relation to loading platform before pouring concrete.
- D. Clean recessed pits of debris.

3.3 INSTALLATION, GENERAL

- A. Install loading dock equipment as required for a complete installation.
 1. Rough-in electrical connections.

3.4 INSTALLATION OF STATIONARY LOADING DOCK LIFTS

- A. Attach dock lifts securely to [loading platform] [floor of recessed pit] [surface of driveway].

3.5 ADJUSTING

- A. Adjust loading dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.
- 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.

3.6 MAINTENANCE SERVICE

- 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.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain loading dock equipment.

END OF SECTION 11 13 19

SECTION 11 40 00 - FOODSERVICE EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Foodservice equipment.

1.2 SCOPE OF WORK:

- A. Furnish all labor, materials and services necessary for the procurement and installation of the equipment included in this section.
- B. Supervise and provide required instructions for work to be performed by other contractors in connection with requirements for all equipment included this section.
- C. Specifications and drawings have been prepared to form the basis for coordination with the other trades on this Project, procurement, erection, start-up and adjustment of all equipment in this section. Plans and specifications are to be considered as mutually explanatory and work required by one, but not by the other, is to be performed as though required by both. Items required by one, but not by the other are to be provided as though required by both. Work to be accomplished as called for in specifications and shown on drawings, so that all items of equipment are completely functional for purpose for which they were designed. When/if there is any discrepancy between drawings and specifications, bidders should seek clarification of any discrepancies from the Consultant prior to bidding.
- D. Should the drawings disagree between themselves, or the specifications with the drawings, the better quality, and more stringent, and greater quantity of work or materials is to be completed without any additional costs to the Owner.
- E. Secure and pay fees for all permits and licenses as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

1.3 RELATED DIVISIONS / SECTIONS:

- A. Refer to General Conditions, Supplementary Conditions, and applicable provisions of Division 1 for additional instructions.
- B. Refer to Interior Design Divisions for applicable provisions and sections regarding décor finishes, applications, details, and special instructions relating to items specified in this Section. Applicable to Projects with items specified in this Section, with décor finishes and/or construction.
- C. Refer to Mechanical/Plumbing Divisions for applicable provisions and sections regarding mechanical services, including, but not limited to; floor sinks and floor drains, water gas and steam rough-ins, grease traps, steam traps, drain traps, atmospheric vents, valves, pipes and pipe fittings, ductwork, and other materials necessary to complete final connections to individual items as specified in this Section. Not work of this Section. Also includes:
 - 1. Piping and insulation for fryer oil systems.
 - 2. Piping for remote pulping systems.
 - 3. All hood or ventilator duct work and fans upstream from the connection position.

- D. Refer to Electrical Divisions for applicable provisions and sections regarding electrical services, including, but not limited to, rough-ins, standard voltage and low-voltage wiring, conduit, drop-cords, ceiling-mounted cord reel assemblies, disconnects and other materials necessary to complete final connections to individual items as specified in this Section. Not work of this Section. Also includes:
1. Installation of light fixtures furnished loose at cold storage rooms.
 2. Connection of cold storage room temperature alarm system to the building security system.
 3. Connection of hood fire suppression system to the building security system.
- E. Work included in other Divisions - Provision of all wall, floor, and/or ceiling/roof openings, and sealing thereof, as necessary for installation of items included in this section. Not work of this Section. Also includes:
1. Slab depressions, reinforced concrete wearing bed and interior finished floor with coved base at prefabricated cold storage assemblies.
 2. Concrete or masonry platforms with finished top and coved base at perimeter, for raised setting of foodservice equipment: Divisions 03/09.
 3. Slab depressions to receive stainless steel drain trench liner/grate assemblies provided under this Section.
 4. Wall backing to support all wall mounted equipment.
 5. Conduit and piping sleeves for soda, beer/liquor, refrigeration, CO2 and drain lines through building ceilings and floors.
- F. Work included in other Divisions - Disconnection of existing equipment to be relocated and/or reused; and removal of existing equipment which will not be reused, as determined and designated by the Architect in other Divisions. Not work of this Section. (Applicable to Projects with existing equipment.)

1.4 DEFINITIONS:

- A. Furnish - Supply and deliver to Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.
- B. Install (set in place) - Operations at Project Site including actual unloading, unpacking, assembly, erecting, placing, anchoring, applying, finishing, curing, protecting, cleaning and similar operations; ready for final utility connections by other Divisions as appropriate.
- C. Provide - Furnish and install complete, ready for intended use, including any necessary initial training.
- D. Contractor - Refers to the Kitchen Equipment (Sub) Contractor in this Section. References to any other Contractor or Division will be specific; such as General Contractor, Plumbing (Sub) Contractor / Division, Electrical (Sub) Contractor / Division, Architect designated, etc.

1.5 LAWS, ORDINANCES, REGULATIONS AND STANDARDS:

- A. Comply with the following in their current published form:
1. Air Conditioning and Refrigeration Institute (A.R.I): applicable regulations and references of the latest edition of standards for remote refrigeration system(s), components and installation.
 2. American Gas Association (A.G.A.): standards for gas heated equipment, and provide equipment with the A.G.A. seal. Automatic safety pilots to be provided

- on all equipment, where available. (Canadian Gas Association or alternate testing lab's seals accepted if acceptable to local code jurisdictions.)
3. American National Standards Institute (A.N.S.I.): Z21-Series for gas-burning equipment. Provide labels indicating name of testing agency.
 4. American National Standards Institute (A.N.S.I.): B57.1 for compressed gas cylinder connections, and with applicable standards of the Compressed Gas Association for compressed gas piping.
 5. American National Standards Institute (A.N.S.I.): A40.4 and A40.6 for water connection air gaps and vacuum breakers.
 6. American Society of Heating, Refrigeration and Air Conditioning Engineers (A.S.H.R.A.E.): applicable regulations and references of the latest edition of standards for remote refrigeration system(s), components and installation.
 7. American Society of Mechanical Engineers (A.S.M.E.): Boiler Code requirements for steam generating and steam heated equipment, and provide A.S.M.E. inspection stamp and registration with National Board.
 8. American Society for Testing and Materials (A.S.T.M.): C1036 for flat glass.
 9. American Society for Testing and Materials (A.S.T.M.): C1048 for heat-treated flat glass - Kind HS, Kind FT coated and uncoated glass.
 10. American Society for Testing and Materials (A.S.T.M.): F232-03 for pre-rinse spray units, and in compliance with Energy Policy Act of 2005 (EPAct).
 11. American Welding Society (A.W.S.): D1.1 structural welding code.
 12. Energy Policy Act of 2005 (EPAct 2005): water savings pre-rinse spray valves.
 13. National Electric Code (N.E.C.): N.F.P.A. Volume 5 for electrical wiring and devices included with foodservice equipment, A.N.S.I. C2 and C73, and applicable N.E.M.A. and N.E.C.A. standards.
 14. National Electrical Manufacturers Association (N.E.M.A.): LD3 for high-pressure decorative laminates.
 15. National Fire Protection Association (N.F.P.A.): applicable sections for exhaust hoods, ventilators, duct and fan materials, hoods fire suppression systems, wheel placement systems, construction and installation; in addition to local codes and standards.
 16. National Sanitation Foundation (NSF): latest Standards and Revisions, and as accredited by ANSI, IAS, NELAC, ISO, OSHA and SCC. Provide NSF Seal of Approval on all standard manufactured items included in this Project and listed in any NSF Certified Food Equipment Products Category, and on all items of custom fabricated work included in this Project. (UL Sanitation approval and seal accepted if acceptable to local code jurisdictions.)
 17. Sheet Metal and Air Conditioning Contractor's National Association (S.M.A.C.N.A.): latest edition of guidelines for seismic restraint of kitchen equipment, as applicable to project location. All seismic requirements shall be shown on all submittals. Submit requested information to the agencies and authorities having jurisdiction.
 18. Underwriters Laboratories (U.L.): as applicable for electrical components and assemblies. Provide either U.L. labeled products or, where no labeling service is available, "recognized markings" to indicate listing in the U.L. "Recognized Component Index". (Canadian Standards Association or alternate testing lab's seals accepted if acceptable to local code jurisdictions.)
 19. UL 300 Standard: for wet chemical fire suppression systems for exhaust hoods/ventilators.
 20. American with Disabilities Act (ADA): as applicable to this Project.
 21. Refrigeration Service Engineers Society (R.S.E.S.): applicable regulations and references of the latest edition of standards for remote refrigeration system(s), components and installation.
 22. All refrigerants used for any purpose is to comply with the 1995 and 2010 requirements of the Montreal Protocol Agreement, and subsequent revisions

- and amendments. No CFC or HCFC refrigerants will be permitted on this Project.
23. All refrigeration components installation, repairs, and/or associated work on any refrigeration system, is to be performed by a Certified Refrigeration Mechanic thoroughly familiar with this type commercial foodservice installation. ETL and other national and international recognized Testing and Listing Agency labels and certifications are acceptable in lieu of Listing Agencies indicated in these documents, if acceptable to the local code jurisdictions.
 24. All applicable local codes, standards and regulations.
 25. All special local codes, standard, and regulations; such as (examples only) California Energy Commissions Regulations, Dade County requirements for walk-in cooler(s) and/or freezer(s).
 26. For detention facilities projects (as applicable): applicable Correctional Standards. Verify the level of security and construction required with the Architect, and provide all items in compliance.
- B. The Contract Documents shall prevail whenever they require larger sizes or higher standards than are required by regulations.
- C. The above regulations shall govern whenever the Contract Documents require something that is deemed to violate the above regulations.
- D. No extra charge will be paid by Owner for furnishing items required by the regulations, but not specified and/or shown on the drawings.
- E. Rulings and interpretations of the enforcing agencies shall be considered a part of the regulations.

1.6 CONTRACTOR'S QUALIFICATIONS:

- A. In addition to requirements of Related Sections 1.2.A:
1. Five (5) years minimum continuous operation under the same company name and ownership.
 2. Financial stability and ability to complete this Project.
 3. Comparable size and scope projects completed in the last five (5) years.
 4. Contractor to provide letter that states they are able to purchase, distribute, and install all items specified.
- B. Any sub-contractor or fabricator employed by Contractor:
1. Is to comply with the same qualifications.
 2. Their name, address, and a brief summary of their experience and qualifications is to be submitted with the bid proposal.
 3. Fabrication sub-contractor shall be NSF, NEC, and UL approved at a minimum for fabrication of all items detailed within this specification and attending drawing set. Moreover, fabrication shop shall have the means and expertise to fully engineer and fabricate any and all counters, tables, natural and man-made stone counter tops, food shields, etc. all in one manufacturing facility where specified as part of this document set.

1.7 BIDDING AND SUBSTITUTIONS:

- A. Unless otherwise instructed by Division 1 bidding instructions, the Bidder shall provide pricing on primary manufacturer and model specified. These Contract Documents were

designed and engineered using the primary manufacturer and model and are intended to be the Basis of Bid. Provide itemized prices for each item, along with cited accessories with separate total prices for delivery and installation. Any and all city, state, occupational and government taxes which are applicable to this project, shall be included and added as a separate charge. All figures shall be included in a grand total package bid proposal. Bids shall be valid for sixty (60) days after bid deadline date, and shall indicate same. Failure to comply with the above may be cause for rejection of the bid.

- B. Unless otherwise noted, substitutions may be submitted for consideration, but must be itemized at the end of the bid proposal.
- C. Substitutions must be approved in writing by the Architect and/or Owner, prior to utilization in this Contract. A copy of the approval must be included with any submittals by Contractor.
- D. Contractor shall provide all design/engineering services required to make adjustments in space, systems, utilities, etc. and pay all additional costs of utilities, construction or professional services that may be incurred due to the acceptance of any substitution.
- E. Application for Substitution of Specified Food Service Equipment. This form is shall be submitted in support of each suggestion of request to substitute an alternate manufacturer and/or model of equipment that is not included in the Division 11- (Food Service Equipment) specifications.

APPLICATION FOR SUBSTITUTION OF SPECIFIED FOOD SERVICE EQUIPMENT

The decision to accept an unnamed alternate will be based exclusively on the information provided hereon and the Owner's or their designee's research and verifications of claims, which shall include sharing the information with manufacturer(s) of the originally specified equipment. Accordingly, any proprietary information regarding the proposed substitution should be so identified and submitted as an addendum to this form.

By submitting this application the Contractor guarantees the information is correct and accepts total responsibility for all additional costs that may directly or indirectly result from acceptance of the proposed substitution. It is the interest of the Contractor to declare in this form all benefits the will accrue to the Owner. Include the proposed manufacturer's data sheets, drawings and any other supporting information.

The original specifications describe the minimum standards of the equipment – proposed substitutions that do not meet or exceed this minimum standard or otherwise benefit the Owner will not be considered except in the case of an originally specified item that is no longer available. The Owner or their designee will be the sole authority in regard to identifying specific features, capacities, etc. that are operationally critical. Acceptance of a proposed substitution does not relieve the Contractor of responsibility for all direct or indirect costs associated with the substitution.

1. Date Submitted:
2. Item Number: Description: Quantity:
3. Specified Manufacturer: Specified Model Number:
4. Proposed Manufacturer: Proposed Model Number:
5. Does the proposed equipment incorporate all features and options expressed or implied by the specifications, including features and option that are provided as standard by the specified item?
 Yes No – describe (attach additional sheets as required):

6. Compare Utilities (attach additional sheets as required):

Specified: HW	CW	Gas (BTU)	Steam (BHP)	Electrical
Exhaust (cfm)	Duct size		Supply (cfm)	Duct size
—				
Proposed: HW	CW	Gas (BTU)	Steam (BHP)	Electrical
Exhaust (cfm) Size	Duct Size		Supply (cfm)	Duct

7. Compare Dimension:

Specified: Left to Right	Front to Rear	Height
Proposed: Left to Right	Front to Rear	Height

8. Does the proposed substitution require changes to the work to be provided by other trades?

No Yes – describe (attach additional sheets as required):

9. Does the proposed substitution require changes or create any issues in regard to adjacent or associated equipment (for instance: door swing interference; service access; air circulation)?

No Yes – describe (attach additional sheets as required):

10. What benefits will the Owner realize as a result of this substitution (for instance: capital expense; energy savings, flexibility)? Provide specific information.

There are no benefits to the Owner.

The following will benefit the Owner – (attach additional sheets as required):

11. Are there any other considerations that should be evaluated? _____

12. Signature of Contractor's Representative: _____

1.8 APPROVED SUBSTITUTIONS AND LISTED ALTERNATES:

- A. Substitutions approved as noted in Article 1.7, and/or any Listed Alternate manufacturers included in the Itemized Specifications Article 3.12, or added by Addendum, may be utilized, in lieu of the primary specified manufacturer with the following conditions:
1. These Contract Documents are designed and engineered using the primary specified manufacturer and model and are intended to be the Basis of Design and Bid. Contractor assumes complete responsibility for any deviations required due to utilization of a substitution/alternate manufacturer or model; including, but not limited to, fitting alternates into available space, providing directions for required changes, and assuming any associated cost for utility, building, architectural, or engineering changes.
 2. Contractor is responsible for supplying the model, which is as close as possible to the primary specified model in regards to general function, features, options, sizes, accessories, utility requirements, finish, operation, internal system engineering and listing approvals. If it is determined by the owner or their appointed representative at any time during the construction and installation process, and prior to the final acceptance of the Project, that the substitution/alternate model submitted is not equivalent to the primary specified model, the Contractor will assume all associated cost and implications required to replace the model submitted, with the correct model.
 3. The bid proposal is to clearly state any proposed substitutions/alternates, that are being offered for review by including the manufacturer and model number. Along with a current data sheet for each substitution/alternate, with any and all deviations between the primary specified manufacturer and the substitution/alternate manufacturer clearly defined. Technical brochures from manufacturers may not be acceptable as adequate information required for comparison. Complex alternates such as utility distribution systems, exhaust hoods, ventilators, refrigeration systems, etc. are shall to include a shop drawing specific to this Project.
 4. Inclusion of an alternate manufacturer in Itemized Specifications Article 3.12 is not intended to indicate that there is an equal alternate unit to match every primary specified unit. It is the responsibility of the Contractor to insure that the alternate unit submitted matches or exceeds the primary specified unit; and meets the conditions as stated above.
 5. Manufacturers not approved as substitutions, or included as a Listed Alternates will not be permitted.

1.9 DISCREPANCIES:

- A. Where discrepancies are discovered between the drawings and the specifications, regarding quality or quantity, the higher quality or the greater quantity is to be included in the Bid Proposal.
- B. Contractor to notify the Architect, in writing, of any discrepancies discovered; and await written clarification prior to proceeding with the items or areas in question.
- C. Contractor is responsible for verifying and coordinating all items provided in this Section, with the drawings, specifications, manufacturer's requirements, submittals, actual site conditions, adjacent items, and associated (Sub-) Contractors; to assure that there are no discrepancies or conflicts. This is to include, but not be limited to, quantities,

dimensions, clearances required, direction of operation, door swings, utilities, fabrication details and methods, installation requirements, etc.

1.10 SUBMITTALS:

- A. Provide one (1) digital set (PDF) of all Submittals for review by the Design Team. After review process this set will be returned for copying and distribution.
- B. Substitutions must be approved in writing by the Architect and/or Owner prior to utilization in this contract. A copy of the approval must be included with any submittals.
- C. Contractor to review all submittals for compliance with the Contract Documents, prior to submitting to the Design Team for review and is responsible for the accuracy of the information within their submittals.
- D. Contractor's use of any Design Team's digital contract drawings for basis of producing their submittal drawings, is with the following conditions and understanding:
 1. Contractor shall assume complete liability and responsibility for accuracy, and for conformance and verification with the latest Architectural and Engineering drawings, actual field conditions, and all equipment provided.
 2. Contractor further assumes responsibility for coordination of their submittals with those of other Contractors and Sub-Contractors, as required.
 3. Submittals shall contain Contractor's notes, symbols, details, title block and information.
- E. Equipment Plan and Rough-In Drawings:
 1. Submit 1/4" (1:50) scale drawings in pdf format. These drawings are to include complete information on the work included in this Contract, with references to equipment as provided by others; and are to provide sufficient information for associated trades, contractors, and/or sub-contractors to complete their division of work associated with food service equipment included in this Contract. Include any additional information pertinent to the installation of this equipment
 2. Special Conditions Drawings, dimensioned, sizing and locating the following conditions:
 - a. Slab depressions, cores, sleeves or block-outs (cold storage assemblies drain trenches, piping, etc.).
 - b. Concrete or masonry platforms.
 - c. Pipe sleeves or roof jacks.
 - d. Wall-openings or block-outs for pass-through equipment, recessed control panels, in-wall fire-protection system components, etc.
 - e. Blocking grounds or anchor plates required in walls for equipment support/attachment.
 - f. Above-ceiling hanger assemblies for support of exhaust hoods, utensil-racks, etc.
 - g. Access panels in walls or ceiling for service of equipment.
 - h. Ceiling pockets or recesses for unusually high equipment.
 - i. In-wall carriers for wall-hung or cantilevered equipment.

- j. Ventilation for exhaust hoods, condensate hoods, ice machines, compressors, compressor racks and all other equipment requiring heat removal.
 - k. Beverage conduit and sleeves.
 - l. Any other additional information pertinent to the installation of this equipment.
 3. Electrical Rough-in Drawings dimensioned and providing the following information but not limited to:
 - a. Electrical utility schedule.
 - b. Locations of rough-ins.
 - c. Locations of control panels.
 - d. Interwiring of walk-in freezer compressors to compressor rack control panel for defrost cycle.
 - e. Interwiring of controls panels to equipment.
 4. Plumbing Rough-In Drawings dimensioned, and providing the following information but not limited to:
 - a. Plumbing utility schedule.
 - b. Locations of rough-ins.
 - c. Interconnection water filters assemblies to ice machine, beverage equipment, combi-ovens, steamers, etc.
 5. Drawings to also include equipment plan(s) with detailed equipment list, similar to Food Service Equipment Plans included in the Contract Drawings. Item numbers are to be the same as shown in the Contract Documents, and are to include Spare Numbers and associated items as provided by others.
 6. In the event rough-ins have been accomplished before award of this contract, Contractor is to examine the existing facility and make adjustments to their equipment to suit building conditions and utilities, where possible. If not possible, so state in a letter, with reasons and an alternate method and pricing for their equipment, to the Architect.
- F. Shop Drawings:
 1. Submit shop drawings for items of custom fabrication included in this contract in pdf format. Shop drawings are to be submitted at 3/4" (1:20) and/or 1-1/2" (1:10) scale and are to show dimensions, materials, details of construction, installation and relation of adjoining work requiring cutting or close fitting. Shop drawings are to also indicate reinforcements, anchorage and related work required for the complete installation of fixtures.
 2. Submit shop drawings for any equipment requiring field assembly, including but not limited to, Waldorf cooking assemblies, pulper/extractor assemblies, remote refrigeration systems, walk-in coolers and/or freezers, exhaust hoods/ventilators, fire suppression system, utility distribution systems, pot/utility/cart/tray/ware washing assemblies/machines, conveyors, floor troughs, seismic anchoring de- tails (as required) and fresh oil supply/waste oil recovery systems in pdf format.
 3. Before proceeding with the fabrication or manufacture of any item, Contractor is responsible for verifying and coordinating all dimensions and details, with site dimensions, conditions, and adjacent equipment.
 4. The Contractor to clearly identify on drawings all differences between the bid documents and what is being provided. If any electrical, plumbing, gas or steam requirements are different than what the bid documents show the Contractor will make a note on the drawings identifying what is different.

- G. Product Data Submittal Manuals:
1. Submit product data brochure(s) with a cover sheet complete with detailed information on every item included in this section in pdf format. Detailed information is to include, but not be limited to, item number, description, quantity, model numbers, options and accessories provided, N.E.M.A. plug and receptacle configuration for applicable items, exact utility requirements, manufacturer's cut-sheets, reference to specific shop drawings, and etc. Distribute one additional copy of installation and start-up instructions to the Installer. Every cover sheet and associated detailed submittal is to provide sufficient and complete information for the Design Team to verify that the Contractor understands the Contract requirements, and is providing each item in compliance with the Contract documents. Cover sheets to also include associated items as listed on the Equipment Plan, but provided by others; and are to be noted as "Not in Section 11 40 00 Contract Division".
 2. Reproduction of any part of the Contract Specifications will not be acceptable as part or total of Contractor's Product Data Submittal Manuals. These Manuals are to be produced and assembled entirely by the Contractor, in numerical order according to Item numbers.
 3. The cover sheet to clearly identify all differences between the bid documents and what is being provided. If any electrical, plumbing, gas or steam requirements are different than what the bid documents show the Contractor will make a note on the coversheet identifying what is different and why. If a model has been discontinued, the Contractor will make a note on the cover sheet and offer a replacement model.
 4. The cover sheet to clearly identify all differences between the bid documents and what is being provided. If any electrical, plumbing, gas or steam requirements are different than what the bid documents show the Contractor will make a note on the coversheet identifying what is different and why. If a model has been discontinued, the Contractor will make a note on the cover sheet and offer a replacement model.
- H. Design Team's review of submittal drawings, shop details, product data brochures, and operation and maintenance manuals is for general conformance with the design concept and contract documents. Review markings or comments are not to be construed as relieving Contractor from compliance with the contract documents, or departures there from. Contractor remains responsible for details and accuracy, confirming and correlating all quantities and dimensions, selecting fabrication processes, techniques of assembly, and performing their work in a safe, satisfactory, code-compliant and professional manner.
- I. Commencement of purchasing or fabrication by the Contractor, of any item(s) included in this Contract, prior to receipt of reviewed Submittals from the Design Team, shall be at the Contractor's own risk; unless specifically instructed to do so in writing by the Owner, including the specific item numbers requested.
- J. Food Service Equipment Contractor shall verify requirements and equipment sizes or other characteristics necessary to represent Owner/ Purveyor items completely on the shop drawing submittals even though they may be listed as "NIC/Not in Contract" in the Equipment Schedule/Item Specification sections of this document.

1.11 OPERATION AND MAINTENANCE DATA MANUALS:

- A. Two (2) bound sets of manuals are to be furnished for items of standard manufacture on/or before the date of the first event to occur of the following: demo/start-up, start-up for intended use by the Owner/Operator, completion of installation of kitchen equipment contract package, or final acceptance of installation by Owner. Manuals are to be in alphabetical order according to manufacturer. Manufacturer's info is to include Tech Services telephone number, email, and web site address, where available.
- B. Provide a complete list of local service agencies for included manufacturers, complete with address and telephone numbers. Also provide email and web site addresses, where available.
- C. Provide electronic/digital media for maintenance, training, operation, etc. where available from the manufacturer.
- D. Manual shall also include a leak testing report for each and every remote refrigerated system included under this Foodservice Equipment Section, as required in article 2.6.A.6 Refrigeration Equipment of this Section.

1.12 AS-BUILT/ RECORD DOCUMENTS:

- A. Maintain one record set of Foodservice Equipment Plans with any related corrections, revisions, additions, deletions, changes, etc. noted during construction and installation. Provide an "as-built" set on a computer disk or electronically in PDF format.
- B. Provide one (1) final set of Product Data Submittal Manual with any related corrections, revisions, additions, deletions, changes, etc. noted during construction and installation as a specifications record set electronically in PDF format.
- C. These documents are to be provided at the same time as the O & M Data Manuals. Submit the O & M Data Manuals electronically in PDF format.

1.13 SCHEDULE:

- A. Time is of the essence and acceptance constitutes assurance that the Contractor can and will obtain materials, equipment and manpower, to permit installation of the items included in this Section, on schedule. Contractor is to coordinate their work with the progress schedule, as prepared and updated periodically by the General Contractor or Construction Manager.
- B. Anticipated delays, not within the control of the Contractor, are to be noted in a written notification to the Architect, immediately upon the Contractor's realization that delays are imminent.
- C. Failure of manufacturers to meet promised delivery dates will not grant relief to the Contractor for failure to meet schedules; unless the Contractor can establish, in writing, that orders were received by the manufacturer, with reasonable lead times.

- D. Extra charges resulting from special handling or air shipment in order to meet the schedule will be paid by the Contractor, if insufficient time was allowed in placing factory orders.

1.14 WARRANTY:

- A. Unless otherwise noted in Related Divisions / Sections 1.2.A, items furnished are to be fully guaranteed against defects in workmanship, materials, and functionality for one full year from the date of the first event to occur of the following: date of issue of Certificate Of Occupancy (or the equivalent), start-up for intended use by the Owner/Operator, completion of installation of kitchen equipment contract package, or final acceptance of installation by Owner. Should a Temporary Certificate of Occupancy be issued for partial completion of work, the items furnished within that designated area are to be under warranty from the date of issue of that Certificate. Contractor or their service agent will make necessary repairs and replacements without charge to the Owner, and within a reasonable time.
- B. Additional Refrigeration Warranty: in addition to the one-year warranty requirements as stated above, provide start-up and parts and labor for the first year; plus additional four-year extended warranty on compressors. Extended warranty is for provision of replacement compressor, determined to be defective by a certified refrigeration mechanic. However verification of defective compressor, installation of replacement compressor, recharging and repairs of system will be the responsibility of the Owner. This includes all items with built-in or remote refrigeration system.
- C. Periodic routine maintenance, servicing, adjustments, cleaning, etc., as required by the manufacturers included in this Project, are the responsibility of the Owner.
- D. Any and all parts or requirements for manufacturer's warranties to be in effect, whether or not noted in the itemized specifications, are to be provided or complied with by the Contractor. This is to include, but not be limited to, particular parts, accessories, or installation; installation supervision, start-up, and/or follow-up inspections required by factory trained, Certified, and/or authorized personnel. Factory training, Certification, and/or authorization is to be in effect at the time of bidding, installation, start-up, and warranty period of this Project.
- E. Unless otherwise noted in Related Divisions manufacturer's warranties which comply with the requirements of this Warranty Article 1.17, are to be provided in lieu of Contractor's own warranties, where available. Copies of the written warranties are to be included in the O & M Manuals.

PART 2 – PRODUCTS

2.1 EQUIPMENT:

- A. Refer to schedule on Foodservice Drawings and Section 3.12 Itemized Specifications for equipment included in this Section.

2.2 MATERIALS:

- A. Metals:
1. Stainless Steel: AISI Type 201 or 302/304, hardest workable temper, and No.4 directional polish. Unless otherwise noted or specified, or required by the manufacturer, 201 may be used wherever 302/304 is listed.
 2. Galvanized Steel Sheet: ASTM A526, except ASTM A527 for extensive forming; ASTM A525, G90 zinc coating, chemical treatment.
 - a. Where painted finish is indicated, provide mill phosphatized treatment in lieu of chemical treatment.
 3. Steel Sheet: ASTM A569 hot-rolled carbon steel.
 4. Galvanized Steel Pipe: ASTM A53 or ASTM A120, welded or seamless, schedule 40, galvanized.
 5. Steel Structural Members: Hot rolled or cold formed, carbon steel unless stainless steel is indicated.
 - a. Galvanized Finish (G.I.): ASTM A123 hot-dipped zinc coating, applied after fabrication.
 6. Aluminum: ASTM B209/B221 sheet, plate and extrusions (as indicated); alloy, temper and finish as determined by manufacturer/fabricator, except 0.40-mil natural anodized finish on exposed work unless another finish is indicated.
- B. Plastic Laminate: NEMA LD3, Type 2, 0.050" (1.27 mm) thick, except Type 3, 0.042" (1.07 mm) for post-forming smooth (non-textured). Color and texture as selected by Architect/ Interior Designer.
1. Comply with N.S.F. Standard No. 35.
 2. Veneered with approved waterproof and heat proof cement. Rubber base adhesives are not acceptable.
 3. Applied directly over close grained plywood, such as solid Mahogany or solid Birch, of selected, smooth, sanded stock to ensure a smooth ripple-free laminated surface; or commercial grade furniture particle board, Cortron or equal.
 4. Exposed faces and edges are to be faced with 1/16" (1.6 mm) thick material. Corresponding backs are to be covered with approved backing and balancing sheet material.
- C. Millwork: No unfinished millwork, plywood/particle board or wood framing (including backs, undersides, and all surfaces concealed from view) will be permitted. All unfinished surfaces or openings cut through finished surfaces are to be sealed to be water resistant; with excess plastic laminate material, Cortron (Melamine) material, backing materials, sealers, primers, finish paint, etc., to blend with specified finish materials.
- D. Hardwood Work Surfaces: Laminated edge grained hard maple (*Acer saccharum*), NHLA First Grade with knots, holes and other blemishes culled out, kiln dried at 8 percent or less moisture, waterproof glue, machined, sanded, and finished with N.S.F. approved oil-sealer.
- E. Solid Surface Material and Simulated/Engineered Stone:
1. Single-Source Responsibility for Solid Surface Material and Simulated/Engineered Stone: Obtain each color, grade, finish, type, and variety of material or stone from a supplier with resources to provide materials of consistent

- quality in appearance and physical properties, including the capacity to cut and finish material without delaying the progress of the work.
2. Single-Source Responsibility for Other Materials: Obtain each type of solid surface material and simulated/engineered stone accessory, sealant, and other materials from one manufacturer for each product.
 3. Installer Qualifications: Trained and approved by countertop manufacturer who has completed countertops similar in material, design, and extent to that indicated for project that has resulted in construction with a record of successful in-service performance.
 4. The Contractor is responsible for verification of delivered stone materials for quantities, defects, or damage within [ten (10) days] after delivery. No compensation will be allowed to the contractor for materials and labor that may be required to replace materials after this time period.
 5. Allowable Tolerances:
 - a. Variation in component size: +/- 1/8 inch in 8 feet.
 - b. Maximum height of abrupt irregularities: 1/32 inch.
 - c. Location of openings: +/- 1/8 inch from indicated location.
 6. Do not deliver countertop materials until painting and similar operations that could damage engineered stone materials have been completed in installation areas. If engineered stone materials must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.
 7. Handle materials to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation for duration of project.
 8. Environmental Limitations: Do not deliver or install simulated stone materials until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
 - a. Maintain ambient temperature between 50 and 95 degrees F for 48 hours before, during and for minimum 7 days after installation.
 9. Field Measurements: Where simulated stone materials are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - a. Locate concealed framing, blocking, and reinforcements that support simulated stone work by field measurements before being enclosed and indicate measurements on Shop Drawings.
 10. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
 11. Adhesive and Sealant as recommended by engineered stone manufacturer.
 12. Sink/bowl mounting hardware:
 - a. Manufacturer's approved bowl clips, brass inserts and fasteners for attachment of under mount sinks/bowls.
 13. Fabrication:
 - a. Fabricate components to greatest extent practical to sizes and shapes indi-

- cated, in accordance with approved shop drawings and manufacturer's printed instructions.
- b. Clean surfaces to remove loose and foreign matter that could impair adhesion.
 - c. Remove ridges and projections. Fill voids and depressions with patching compound compatible with setting materials.
 - d. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings.
 - e. Rout and finish component edges with clean, sharp returns. Rout cutouts, radii and contours to template. Smooth edges. Repair or reject defective and inaccurate work.
 - f. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trip for scribing and site cutting.
 - g. Thickness: Provide thickness indicated, but not less than the following:
 - i. Countertop: 1-1/4 inches
 - ii. Back and End Splashes: 1-1/4 inch, unless shown otherwise.
- F. Stone:
1. Single-Source Responsibility for Stone: Obtain each color, grade, finish, type, and variety of stone from a supplier with resources to provide materials of consistent quality in appearance and physical properties, including the capacity to cut and finish material without delaying the progress of the work.
 2. Single-Source Responsibility for Other Materials: Obtain each type of stone accessory, sealant, and other materials from one manufacturer for each product.
 3. Installer Qualifications; Engage an experienced installer who have completed stone countertops similar in material, design, and extent to that indicated for project that has resulted in construction with a record of successful in-service performance.
 4. The Contractor is responsible for verification of delivered stone materials for quantities, defects, or damage within ten (10) days after delivery. No compensation will be allowed to the contractor for materials and labor that may be required to replace materials after this time period.
 5. Allowable Tolerances:
 - a. Variation in component size: +/- 1/8 inch in 8 feet.
 - b. Maximum height of abrupt irregularities: 1/32 inch.
 - c. Location of openings: +/- 1/8 inch from indicated location.
 6. Granite materials shall not contain unsafe levels of radioactive materials.
 7. Do not deliver countertop materials until painting and similar operations that could damage stone materials have been completed in installation areas. If stone materials must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.
 8. Deliver materials to project site in undamaged condition.
 9. Store and handle stone and related materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, break- age, chipping, or other causes.
 - a. Do not use pinch or wrecking bars.

- b. Lift with wide-belt-type slings where possible. Do not use wire rope or ropes containing tar or other substances that might cause staining. If required to move stone, use wood rollers with cushions at end of wood slides.
 - c. Store stone on wood skids or pallets covered with non-staining, waterproof membrane.
 - d. Place and stack skids and stones to distribute weight evenly and to prevent breakage or cracking of stones.
 - e. Protect stored stone from weather with waterproof, non-staining covers or enclosures, but allow air to circulate around stones.
 - f. Store cementitious materials off the ground, under cover, and in dry location.
10. Environmental Limitations: Do not deliver or install stone materials until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- a. Maintain ambient temperature between 50 and 95 degrees F for 48 hours before, during and for minimum 7 days after installation.
11. Field Measurements: Verify dimensions of construction to receive stone countertops by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.
- a. Established Dimensions: Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating countertops without field measurements. Provide allowance for trimming at site and coordinate construction to ensure actual dimensions correspond to established dimensions.
12. Comply with referenced standards and other requirements indicated applicable to each type of material required.
13. Provide matched slabs, coordinated for each type, variety, color, and quality of stone required.
14. The use of colored tints, dyes, or waxes applied to stone shall NOT be permitted
15. Granite:
- a. Granite Building Stone Standard: ASTM C615, free from cracks, chips, stains, or other defects, uniform in tone and coloring.
16. Marble:
- a. Marble Building Stone Standard: ASTM C503, free from cracks, chips, stains, or other defects, uniform in tone and coloring.
17. Adhesives:
- a. Stone Seam Adhesive: 2-part, epoxy or polyester stone adhesive formulated specifically for bonding stone to stone, with an initial set time of not more than 2 hours at 70 deg F.
 - b. Water-cleanable Epoxy Adhesive: ANSI A118.3, water-cleanable, tile-setting epoxy adhesive.
 - c. Color: Clear
 - d. Use installation adhesives that have a VOC content 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), or as listed in VOC limit tables in Section 01 81 19 "Indoor Air Quality Requirements". Products furnished shall comply with whichever VOC con-

- tent requirement is more stringent.
18. Stone Sealants:
 - a. Sealant for Countertops: Clear silicone sealant complying with requirements of Section 07 92 00 "Joint Sealants".
 - b. For sealants used inside of the vapor barrier, provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), or as listed in VOC limit tables in Section 01 81 19 "Indoor Air Quality Requirements". Products furnished shall comply with whichever VOC content requirement is more stringent.
 19. Stone Sealers:
 - a. Penetrating Sealer: Penetrating sealer that protects the exposed faces of stone and grout from staining. Sealer shall be UV transparent; non-yellowing; VOC compliant; mold and mildew resistant; and USDA approved as safe on food handling surfaces. Material shall exceed ADA standards for slip resistance at traffic areas.
 - b. For sealers used inside of the vapor barrier, provide sealers that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), or as listed in VOC limit tables in Section 01 81 19 "Indoor Air Quality Requirements". Products furnished shall comply with whichever VOC content requirement is more stringent.
 20. Cutouts and Holes for Lavatories, Sinks, and Fittings:
 - a. Undercounter Lavatories: Make cutouts for undercounter lavatories in shop using template or pattern furnished by lavatory manufacturer. Form cutouts to smooth, even curves with edges at right angles to top. Ease juncture of cutout edges with tops, and finish edges to match tops.
 21. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
- G. Insulation:
1. For low temperature applications, such as ice bins, cold pans, or fabricated under counter freezers, use urethane, rigid board foam or foamed-in-place; not less than 2" (50 mm) thick, except that vertical surfaces of cold pans and ice bins may be 1" (25 mm) thick. Insulation to be bonded at joints, to prevent condensation on exterior.
 2. For refrigerated applications such as fabricated under counter refrigerators, use urethane rigid board foam or foamed-in-place, or Styrofoam rigid board foam 2" (50 mm) thick, bonded at joints. No fiberglass insulation will be permitted.
 3. For heated type applications, such as plate warmers, use block type rock wool, minimum 1" (25 mm) thick; or Marinite I as noted in #4 below.
 4. At counters subject to direct or indirect heat from heating or cooking equipment, use 1" (25 mm) thick BNZ Materials, Inc. (303-978-1199) Marinite I, or equal, to insulate between counter and heat source. In addition, provide a 1" (25 mm) minimum air space between the heat source and the insulation.
 5. All insulation is to be fully encased or enclosed in 16 gauge (1.6 mm) stainless steel.
- H. Joint Materials:
1. Sealants: water proof and mildew resistant silicone sealant, with Shore A hardness of 30, except 45 if subject to traffic, and minimum service temperature

range of -60° to +400° F. Sealant to be N.S.F. Standard #51 Listed, and FDA and USDA Approved for use in food zones. Surfaces cleaning and sealants installation to comply with applicable requirements of FDA, USDA, and N.S.F. Standards, and accepted foodservice installation practices.

2. Backer Rod: For 3/8" (9.5 mm) or larger joints, to be polyurethane rod stock, larger than joint width.
3. Gaskets: Solid or hollow (but not cellular) neoprene or polyvinyl chloride; light grey, minimum of 40 Shore A hardness, self-adhesive or prepared for either adhesive application or mechanical anchorage.

I. Paint And Coatings:

1. Provide the types of painting and coating materials which, after drying or curing, are suitable for use in conjunction with foodservice, and which are durable, non-toxic, non-dusting, non-flaking, mildew resistant, and comply with N.S.F. Standards and governing regulations for foodservice.
2. Galvanize Repair Paint: MIL-P-21035.
3. Sound Deadener: N.S.F. listed sound deadening material such as latex sound deadener, for internal surfaces of metal work, and underside of metal counters and tables between work top and underbracing. Verify sound deadening requirements or restrictions with local health authorities.
4. Pretreatment: SSPC-PT2 or PT3, of FS TT-C490.
5. Primer Coating for Metal: FS TT-P-86, type suitable for baking, where indicated.
6. Enamel for Metal: Synthetic type, FA TT-P-491, type suitable for baking, where indicated.

2.3 FABRICATED PRODUCTS:

- A. Hardware (also refer to article 2.4 Fabrication Of Metal Work in general, and paragraphs O. Doors 1-3 and P. Drawer Assemblies 1-6 specifically, for additional requirements):
1. General: Manufacturer's standard, but not less than ANSI 156.9 Type 2 (Institutional), satin finish stainless steel or dull chrome finish on brass, bronze, or steel.
 2. Hinged Door Hardware: Stainless steel hinged doors to be mounted with heavy duty N.S.F. approved hinges with Component Hardware Group, Model No. P62-1010 pulls, or equal; or full length pulls as per individual itemized specifications and shown on Standard Detail FSD1-24. Catches to be heavy-duty magnetic type, except as otherwise indicated. Millwork cabinet hinged doors to be mounted with Blum 95° CLIP top thick door all metal hinges, nickel plated, with 3 dimensional adjustment, or equal; or as per individual itemized specifications.
 3. Drawer Hardware: Slides to be 200 pounds (90 kilograms) minimum capacity per pair, 201 or 300 series stainless steel, full extension, side-mounting, self-closing type, with stainless steel ball-bearings, and positive stops; Component Hardware Group Series S52, or equal. Pulls to be Component Hardware Group, Model No. P62-1012, or equal; or full length pulls as per individual itemized specifications and shown on Standard Detail FSD1-24.
 4. Sliding Door Hardware: Sliding doors to be mounted on large, quiet ball bearing rollers in 14 gauge (2 mm) stainless steel overhead tracks, and be removable without the use of tools. Bottom of cabinet to have stainless steel guide-pins and not channel tracks for doors.

5. All hardware to be identified with manufacturer's name and number, so that broken or worn parts may be replaced.
- B. Casters:
1. Type and size as recommended by caster manufacturer, N.S.F. approved for the type and weight of equipment supported; normally 5" (127 mm) diameter heavy-duty, ball-bearing, solid or disc wheel with non-marking grease proof rubber, neoprene or polyurethane tire; unless otherwise specified. Minimum width of tread to be 1-3/16" (30 mm). Minimum capacity per caster to be 250 pound (113.4kg), unless otherwise noted in itemized specifications.
 2. Solid material wheels to be provided with stainless steel rotating wheel guard.
 3. To be sanitary, have sealed wheel and swivel bearings and polished plated finish per N.S.F.
 4. Unless otherwise indicated, equip each item with two (2) swivel-type casters and two (2) fixed casters, with foot brakes on two (2) casters.
 5. Unless item is equipped with another form of all-around protective bumper, provide circular rotating bumper above each caster, 5" (127 mm) diameter tire of light grey synthetic rubber (hollow or closed-cell) on cadmium-plated disc.
- C. Plumbing Fittings, Trim And Accessories:
1. General: Where exposed or semi-exposed, provide bright chrome plated brass or polished stainless steel units. Provide copper or brass where not exposed.
 2. Vacuum Breakers: Provide with foodservice equipment as listed in the itemized specifications.
 3. Water Outlets: At sinks and at other locations where water is supplied (by manual, automatic or remote control), furnish commercial quality faucets, valves, dispensers or fill devices, of the type and size indicated, and as required to operate as indicated.
 4. Waste Fittings: Except as otherwise indicated, furnish 2" (50 mm) remote-lever ball valve type waste valve, and 3-1/2" (89 mm) flat strainer.
 5. Also refer to article 2.4.K for additional information.
- D. Electrical Materials:
1. General: Provide standard materials, devices and components as recommended by the manufacturer or fabricator, selected and installed in accordance with N.E.M.A. standards and recommendations; and as required for safe and efficient use and operation of the foodservice equipment, without sanitation problems.
 2. Components to bear the U.L. label or be approved by the prevailing authority.
 3. Custom fabricated refrigerated/freezer units to be provided with vapor tight light receptacles, shatterproof lamps and automatic switches. Wiring to be concealed.
 4. Where light fixtures are specified or detailed as part of counters, cases or fixtures; light fixtures with lamps to be furnished and installed. Warm white lamps to be provided, unless otherwise specified. If fluorescent light fixtures are specified, ballasts and tubes to be provided. Shields to be provided for all light fixtures.
 5. Convenience and Power Outlets: Make cutouts and install appropriate boxes or outlets in fabricated fixtures, complete with wiring, conduit, outlet and stainless steel cover plate. Outlets and plugs to conform to N.E.M.A. standards. Electrical outlets and devices to be first quality "Specification Grade". GFCI outlets to be

furnished where adjacent to sink compartments, as per the National Electrical Code.

6. Plugs and Cords: Where cords and plugs are provided, they are to comply with National Electrical Manufacturer's Association (N.E.M.A.) requirements. Indicate N.E.M.A. configuration for each applicable item.
7. Power Characteristics: Refer to Electrical Divisions specifications for project power characteristics. Also, refer to individual equipment requirements, for loads and ratings.
8. All electrical components (J-boxes, conduit, outlets, switches, cover plates, light fixtures, panels, etc.) built into or on any equipment provided by the KEC, other than standard buy-out factory manufactured equipment, is to be vapor or water tight type. Provide buy-out equipment with vapor or water tight electrical components wherever available.

2.4 FABRICATION OF METALWORK:

A. General Fabrication Requirements:

1. Remove burrs from sheared edges of metalwork, ease the corners and smooth to eliminate cutting hazard. Bend sheets of metal, at not less than the minimum radius required to avoid grain separation in the metal. Maintain flat, smooth surfaces, without damage to finish.
2. Reinforce metal at locations of hardware, anchorages and accessory attachments wherever metal is less than 14 gauge (2 mm), or requires mortised application. Conceal reinforcements to the greatest extent possible. Weld in place, on concealed faces.
3. Exposed screws or bolt heads, rivets and butt joints made by riveting straps under seams and then filled with solder, will not be accepted. Where fasteners are permitted, provide Phillips head, flat or oval head machine screws. Cap threads with acorn nuts, unless fully concealed in inaccessible construction; and provide nuts and lockwashers unless metal for tapping is at least 12 gauge (2.5 mm). Match fastener head finish with finish of metal fastened.
4. Where components of fabricated metal work are indicated to be galvanized, and involve welding or machining of metal heavier than 16 gauge (1.6 mm), complete the fabrication and provide hot-dip galvanizing of each component, after fabrication, to the greatest extent possible (depending upon available dip-tank sizes). Comply with ASTM A123.
5. Welding And Soldering:
 - a. Materials 18 gauge (1.3 mm), or heavier, to be welded.
 - b. Seams and joints to be shop welded or soldered as the nature of the material may require.
 - c. Welds to be ground smooth and polished to match original finish.
 - d. Where galvanizing has been burned off, the weld is to be cleaned and touched up with high grade aluminum paint.
6. Provide removable panels for access to mechanical and electrical service connections, which are concealed behind or within foodservice equipment, but only where access is not possible and not indicated through other work.
7. Where ends of fixtures, splashbacks, shelves, etc., are open, fill by forming the metal or welding sections, if necessary, to close entire opening flush to walls or adjoining fixtures.

8. Rolled edges are to be as detailed, with corners bullnosed, ground and polished.
9. Equipment to have 1/2" (12.7 mm) or larger radius coves in horizontal and vertical corners, and intersections, per N.S.F. standards.

B. Metal And Gauges:

1. Except as otherwise indicated, fabricate exposed metalwork of stainless steel; and fabricate the following components from the gauge of metal indicated, and other components from not less than 20 gauge (1 mm) metal:
 - a. Table and counter tops: 14 gauge (2 mm)
 - b. Sinks and drainboards: 14 gauge (2 mm)
 - c. Shelves: 16 gauge (1.6 mm)
 - d. Front drawer and door panels: 18 gauge (1.3 mm)
(double-pan type)
 - e. Single pan doors and drawer fronts: 16 gauge (1.6 mm)
 - f. Enclosed base cabinets: 18 gauge (1.3 mm)
 - g. Enclosed wall cabinets: 18 gauge (1.3 mm)
 - h. Exhaust hoods and ventilators: 18 gauge (1.3 mm)
 - i. Pan-type insets and trays: 16 gauge (1.6 mm)
 - j. Removable covers and panels: 18 gauge (1.3 mm)
 - k. Skirts and enclosure panels: 18 gauge (1.3 mm)
 - l. Closure/trim strips over 4" (102 mm) wide: 18 gauge (1.3 mm)
 - m. Hardware reinforcement: 12 gauge (2.5 mm)
 - n. Gusset plates: 10 gauge (3.4 mm)

C. Work-Surface Fabrication:

1. Fabricate metal work surfaces by forming and welding, to provide seamless construction; using welding rods matching sheet metal, grinding and polishing. Where necessary for disassembly, provide waterproof gasketed draw-type joints with concealed bolting.
2. Reinforce work surfaces 30" (762 mm) on center both ways, with galvanized or stainless steel concealed structural members. Reinforce edges, which are not self-reinforced, by formed edges.

D. Metal Top Construction:

1. Metal tops to be one-piece welded construction, including field joints. Secure to a full perimeter galvanized steel channel frame cross-braced not farther than 30" (762 mm) on center. Fasten top with stud bolts or tack welds. If hat sections are used in lieu of channels, close ends.
2. Properly designed draw fastening, trim strip, or commercial joint material to suit requirement is to be used, only if specified.

E. Structural Framing:

1. Except as otherwise indicated, provide framing of minimum 1" (25 mm) pipe-size round pipe or tube members, with mitered and welded joints and gusset plates, ground smooth. Provide 14 gauge (2 mm) stainless steel tube for exposed framing, and galvanized steel pipe for concealed framing.
2. Where indicated, flange rear and end edges up to form splashes integrally with top, with vertical and horizontal corners coved of not less than 1/4" (6 mm) radius, die formed. Turn back splashes 1" (25 mm) to wall across top and ends with

- rounded edge on break, unless otherwise specified.
3. For die-crimped edges, use inverted "V" 1/2" (13 mm) deep inside and 2" (50 mm) deep on outside, unless otherwise shown. For straight down flanges, make 1-3/4" (45 mm) deep on outside. For bullnose edges, roll down 1-3/4" (45 mm).
 4. Edges: die-formed, integral with top. For rounded corners, form to 1" (25 mm) radius, weld, and polish to original finish.
- F. Field Joints: For any field joint required because of size of fixture; butt-joint, reinforce on underside with angles of same material, bolt together with non-corrosive bolts and nuts, field weld, grind and polish.
- G. Pipe Bases: Construct pipe bases of 1-5/8" (41 mm) diameter 18 gauge (1.3 mm) stainless steel tubing. Fit legs with polished stainless steel sanitary adjustable bullet feet to provide for adjustment of approximately 1-1/2" (37 mm), without exposing threads. Space legs to provide ample support for tops, precluding any possibility of buckling or sagging and in no case more than 6' -0" (1829 mm) centers.
- H. Legs and Crossrails
1. Equipment legs and crossrails to be 1-5/8" (41 mm), 16 gauge (1.6 mm) stainless steel tubing.
 2. Welds at cross rails to be continuous and ground smooth. Tack welds will not be acceptable.
 3. Bottom of legs to be swedged inward and fitted with a stainless steel bullet-type foot with not less than 2" (50 mm) adjustment.
 4. Free standing legs to be pegged to floor with 1/4" (6 mm) stainless steel rod, or provided with bolt down type flanged feet anchored to the floor; depending on expected severity of use and/or abuse.
 5. Components:
 - a. Steel Gusset: Stainless steel exterior to fit 1-5/8" (41 mm) tubing, with Allen screw for fastening and adjustment. Not less than 3" (76 mm) diameter at top and 3-3/4" (95mm) long. Outer shell 16 gauge (1.6 mm) stainless steel, reinforced with 12 gauge (2.5 mm) mild steel insert welded interior shell, or approved equal.
 - b. Stainless Steel Low Counter Legs: Stainless steel exterior 5-3/4" (146 mm) minimum, 7" (178 mm) maximum length with stainless steel 3-1/2" (89 mm) square plate with four counter-sunk holes, welded to top for fastening.
 - c. Stainless Steel Adjustable Foot: Stainless steel 1-1/2" (37 mm) diameter tapered at bottom to 1" (25 mm) diameter, fitted with threaded cold rolled rod for minimum 1-1/2" (37 mm) diameter x 3/4" (19 mm) threaded bushing plug welded to legs, or approved equal. Push-in foot not acceptable.
 6. Legs to be fastened to equipment with gussets, as follows:
 - a. Sinks: Reinforced with bushings and set screw.
 - b. Metal Top Tables and Dish Tables: Welded to galvanized steel channels, 14 gauge (2 mm) or heavier, anchored to top with screws through slotted holes.
 - c. Wood Top Tables: Welded to stainless steel channels, 14 gauge (2 mm) or heavier, anchored to top with screws through slotted holes.

- I. Shelves:
1. Construct solid shelves under pipe base tables of 16 gauge (1.6 mm) stainless steel, with 1-1/2" (37 mm) turned down and under edges on exposed sides, and 2" (50 mm) turn up against walls or equipment. Fully weld to pipe legs.
 2. In fixtures with enclosed bases, turn up shelves on back and sides with 1/4" (6 mm) (minimum) radius and feather slightly to ensure a tight fit to enclosure panels.
- J. Sinks:
1. Construct sinks of 14 gauge (2 mm) stainless steel with No.4 finish inside and outside.
 2. Form back, bottom and front of one piece, with ends and partitions welded into place. Partitions: double thickness, 2" (51 mm) minimum space between walls. Multiple compartments to be continuous on the exterior, without applied facing strips or panels.
 3. Cove interior vertical and horizontal corners of each tub not less than 1/4" (6 mm) radius, die formed. Outer ends of drainboards to have roll rim risers not less than 3" (76 mm) high.
 4. Drill faucet holes in splashes 2-1/2" (63.5 mm) below top edge. Verify center spacing with faucet specified.
 5. Sink insets to be deep drawn of 16 gauge (1.6 mm), or heavier, polished stainless steel. Weld into sink drainboards with 1-1/2" (37 mm) x 1-1/2" (37 mm) x 14 gauge (2 mm) stainless steel angle brackets; securely welded to sinks and galvanized cross angles spot welded to underside of drainboards to form an integral part of the installation.
 6. The bottom of each compartment is to be creased such as to ensure complete drainage to waste opening. Slope bottom of sink bowls toward outlet.
- K. Drains and Wastes and Faucets:
1. Furnish and install Fisher model 28940, or equal, ball valve type rotary drain assembly with flat strainer and connected overflow assembly, with chrome finish, in die-drawn inset type sinks and Bain Marie sinks.
 2. Other custom fabricated sinks to be furnished with Fisher model 28932, or equal, ball valve type rotary drain assembly, with flat strainer and chrome finish. Waste connection to have 2" (50 mm) external thread size, with 1-1/2" (37 mm) internal thread size.
 3. Rotary Handle: Of sufficient length to extend to front edge of sink. No riveting, screws or soldering permitted to fit drains to sinks, with all parts of drains easily removable for servicing and replacement.
 4. All faucets furnished with equipment included in this Section to be lead free and comply with N.S.F. Standard #61, Section #9; such as manufactured by Fisher, Chicago, or T&S.
 5. Faucets and pre-rinse spray assemblies furnished with equipment included in this Section, are to have a maximum GPM flow rate in compliance with the Energy Policy Act of 2005 (EPAAct) and later updates; or local requirements, whichever is lower. EPAAct / local requirements are to be applicable to all faucets and pre-rinses; except for pre-rinse type assemblies used at glass icing / fill stations, fill

hose / faucet assemblies at high water usage cooking equipment such as kettles, tilt fry pans, etc., and fill faucets at high volume / usage sinks such as pot and prep sinks, etc. are to have flow rates of approximately 5 gpm flow minimum.

6. All flex hose type faucet assemblies, such as pre-rinses, kettle fill hoses, etc., to have an inline pressure type back flow preventer in the hose assembly, as required by local codes.
7. All equipment provided by this Contractor, which discharges liquid waste exceeding 140° F (60° C), is to be provided with a cold water drain tempering assembly per local codes.

L. Workmanship:

1. Best quality in the trade. Field-verify dimensions before fabricating; conform all items to dimensions of building; neatly fit around pipes, offsets and other obstructions.
2. Fabricate only in accordance with approved shop drawings, showing pipes, obstructions to be built around, and location of utilities and services.

M. Casework:

1. Enclosure: except as otherwise indicated, provide each unit of casework (base, wall, overhead and free-standing) with a complete-enclosure metal cabinet, including fronts, backs, tops, bottoms, and sides.
2. Bases to be made of 18 gauge (1.3 mm) stainless steel sheets reinforced by forming the metal.
3. Ends, partitions and shelves to be stainless steel.
4. Unexposed backs and structural members may be galvanized, unless otherwise noted.
5. Vertical ends and partitions to be single wall, with a 2" (50 mm) face.
6. Sides and through partitions are flush with bottom rail, welded at intersections.
7. Shelves: Provide adjustable standards for positioning and support of shelves in casework; except bottom shelf of cabinet mounted on legs or as specified. Turn back of shelf units up 2" (50 mm) and hem. Turn other edges down to form open channel. Reinforce shelf units to support 40 pounds per square foot (195 kgs/sq meter) loading, plus 100 percent impact loading.
8. Bottom front rail of bases set on masonry platform to be continuously closed and sealed to platform.

N. Doors:

1. Metal doors to be double-cased stainless steel. Outer pans to be 18 gauge (1.3 mm) stainless steel with corners welded, ground smooth and polished. Inner pan to be 20 gauge (1 mm) stainless steel fitted tightly into outer pan with a sound deadening material such as Celotex or Styrofoam used as a core. The two pans to be tack welded together and joints solder filled. Doors to finish approximately 3/4" (19 mm) thick, and be fitted with flush recessed type stainless steel door pulls; or full length pulls as per individual itemized specifications and shown on Standard Detail FSD1-24.
2. Wood doors to be fabricated as detailed.
3. Hinged doors to be mounted on heavy-duty N.S.F. approved hinges, or as noted on plans or specifications.

- O. Drawer Assemblies:
1. Assemblies to consist of removable drawer body mounted in a ball bearing slide assembly with fully enclosed housing.
 2. Slide assembly consists of one pair of 200 pound (90 kilograms) capacity stainless steel roller bearing full extension slides, with side and back enclosure panels, front spacer angle, two drawer carrier angles, secured to slides and stainless steel front.
 3. Drawers intended for tools and general non-food products storage are to have 20" x 20" x 6" deep (508 mm x 508 mm x 152 mm), 18 gauge (1.3 mm) minimum stainless steel drawer pans.
 4. Drawers intended to hold food products are to have 12" x 20" x 6" deep (305 mm x 508 mm x 152 mm) stainless steel food pans.
 5. All drawer pans to be easily removable without tools or disassembly of any drawer assembly components.
 6. Drawer fronts are double cased, 3/4" (19 mm) thick, with 18 gauge (1.3 mm) stainless steel welded and polished front pan. Steel back pan is tightly fitted and tack welded. Sound deaden with rigid insulation material.
 7. Provide drawers with replaceable soft neoprene bumpers or for refrigerated drawers, a full perimeter replaceable refrigerator gasket.
- P. Closed Base: Where casework is indicated to be located on a raised-floor base, prepare casework for support without legs, and for anchorage and sealant application, as required for a completely enclosed and concealed base.
- Q. Support from Floor: Equip floor supported mobile units with casters, and equip items indicated as roll-out units, with manufacturer's standard one-directional rollers. Otherwise, and except for closed-base units, provide pipe or tube legs, with adjustable bullet-design feet for floor supported items of fabricated metalwork. Provide 1-1/2" (37 mm) adjustment of feet (concealed threading).
- R. Shop Painting:
1. Clean and prepare metal surfaces to be painted; remove rust and dirt. Apply treatment to zinc coated surfaces, which have not been mill phosphatized. Coat welded and abraded areas of zinc coated surfaces, with galvanize repair paint.
 2. Apply 1.5 mil (dry film thickness) metal primer coating, followed by 2, 1.0 mil (dry film thickness) metal enamel finish coatings.
 3. Bake primer and finish coatings in accordance with paint manufacturer's instructions for a baked enamel finish.
- S. Sound Deadening:
1. Sound deaden underside of metal tops, drainboards, undershelves, cabinet interior shelves, etc., above the underbracing/reinforcing/framing only.

2.5 ARCHITECTURAL MILLWORK EQUIPMENT:

- A. The following general requirements shall govern the construction of millwork built fixtures, except where otherwise noted. Work shall be performed by skilled mechanics of the trade and shall be of the highest quality throughout, in such a manner as to fulfill the intent of the Contract Documents. Perform architectural woodwork in accordance with

“Architectural Woodwork Quality Standards” published by the Architectural Woodwork Institute (AWI). Fabricator shall have a demonstrated ability in fabricating woodwork items similar in type and quality to those required for this project

1. All fixtures shall be made by one manufacturer and assembled in single and complete units as the dimensions will permit shipment to and installation of at the building. Large pieces requiring sectional construction shall have their parts accurately fitted and aligned with all others, and provided with ample screws, glue and bolt blocks, tongues, grooves and splines, dowels, mortises and tenons, screws, bolts or suitable means of concealed fastening, as required to render the work substantial, rigid and permanently secured in proper position to each related section.
 2. Sufficient additional material shall be allowed to permit accurate scribing to walls, floor and related work, and due allowance made whenever possible for such shrinkage as may develop after installation. Single and sectional units shall be provided with adequate cleating, blocking, crating and other forms of protection as required precluding damage during shipping and handling.
 3. Framing and blocking members shall be assembled with bolted and screwed connections and should be secured to the structural backing with cinch, expansion screws or toggle bolts, as required; spaced and installed to insure ample strength and rigidity. Rails and stiles shall be mortised and tenoned, work neatly mitered and membered, all butt joints made flush and smooth, and all permanent joints made up with water resistant glue. All fixtures shall be assembled without face screws or nails, except where it may be necessary to attach items. All face screws or nails which are necessary shall be counter sunk and plastic wood or wood plugs used to cover head, and the plug neatly touched up. The heads of all screws used in any assembly shall be counter sunk below the surface.
 4. The core material shall be marine grade, 7 ply substrate or MEDEX exterior resin medium density fiberboard substrate; conform to ANSI A208.2.3.3.4. All substrate materials shall be LEED certified and meet the LEED requirements for the project.
 5. Back sheet shall be NEMA LD .020” thick, Type V, Grade 91 plastic laminate; apply on all surfaces not covered with plastic laminate; coordinate color with exposed surface color; comply with NSF Standard 35.
- B. Construction / Joints:
1. Follow AWI Premium Grade Standards; factory assembled parts and prefinished; flush type fronts and overlapping ends; $\frac{3}{4}$ ” core material base cabinet, end and dividers with corner joints between framed members fully lock-jointed, glued and screwed; dado and glue cabinet backs into sides and bottom; scribe counter top and backsplashes; secure countertops to base cabinet from underside; fully cure surfaces prior to installation. Mortise and tenon, spline, dowel and/or pin lock and glue work to avoid use of nails wherever practical. Make butt joints with an approved device for prevention of separation of members. Blind nail and conceal.
- C. Plastic Laminate:
1. Plastic laminate shall be bonded to all exposed surfaces with Urac 185 adhesive or equal, to minimum $\frac{3}{4}$ ” fir faced, close grain marine grade plywood applied under high pressure. In accordance with AWI 1600A-G-1, use horizontal

- grade on all exposed surfaces, vertical grade on semi- exposed surfaces and sealed paint on all concealed surfaces. Reject plastic laminate or plastic backing shall be used to prevent warping, unless otherwise specified. All edges shall be carefully sanded to smooth finish, removing burns, nicks and cur marks. Plastic laminate joints shall be finished without wavy and unsightly joints. Joints need not be mitered except as specified. Hand sand edges to a slight chamfer.
2. Top sheet shall be placed on and over finished edge. Ease exposed edge to over- lap sheet. Use largest sheet possible in order to minimize seams.
 3. Coved backsplashes shall be a minimum of $\frac{1}{4}$ ". End splashes may have a square intersection with tabletops unless specified otherwise.
 4. Plastic laminated shelves shall be laminated with horizontal grade laminate on the side and vertical grade at all edges.
- D. Doors, Hinged:
1. Hinged doors shall be fabricated of $\frac{3}{4}$ " thick marine grade plywood with hardwood full perimeter edge with plastic laminate on face and self-edging on exposed sides unless indicated otherwise in drawings and details. Door hinges, pulls and catches shall be supplied and detailed. Provide Grass 1200, 176 degree opening concealed casework hinges or equal by Blum or Amerock. Door catches shall be Component Hardware Model M22-2420 for non-magnetic and Model M30-2400, heavy duty, self- aligning for magnetic.
 2. Utilize EPCO Model MC 4023.5 or as specified in the Item Specifications.
 3. Door locks shall be Component Hardware Model P30 Series; stainless faced; master keyed as specified.
- E. Doors, Sliding:
1. Sliding doors shall be fabricated of solid core marine grade plywood with hardwood edges and constructed similar to hinged doors. Doors shall be mounted on E-Z Glides track. Doors shall be removable without the use of tools. Rubber stops shall be provided concealed in end stile or mullion.
- F. Access Panels: Access panels shall be fabricated of $\frac{3}{4}$ " nominal thick hardwood and shall be fabricated as a door. Each access panel shall be provided with 2 (two) magnetic catches at top and 2 (two) $\frac{3}{16}$ " positioning pins at bottom.
- G. Drawers:
1. Drawers shall have dovetail construction, well glued and blocked. Fronts shall be not less than $\frac{3}{4}$ " thick hardwood. Sides and back shall be $\frac{1}{2}$ " thick fabricated of Birch, Maple, or Sycamore except where extension slides are used, in which the side shall be $\frac{5}{8}$ " thick. Bottom shall be milled into fronts and sides.
 2. Drawers shall be provided with suitable stops. Provide pulls as detailed or specified. The inside surfaces of all drawers shall receive one coat of penetrating primer and one coat of glass lacquer.
- H. Painted Finishes:
1. Painted finishes shall have exposed surfaces free from defects and blemishes that would show after being finished, regardless of grade specified. All surfaces specified to receive paint or enamel finish shall receive one cross coat of lacquer type undercoat. The undercoat shall be of appreciably different color from that of the

finish coat, and of proper ground color with relation to the finish coat. After the undercoat has been thoroughly dried, surfaces shall be sanded smooth and two coats of enamel shall be applied. Back painting shall be provided for all cabinet and woodwork prior to installation.

- I. Interior & Wall Shelves:
 - 1. Interior shelves shall be adjustable with flush routed-in shelf standards. Wall shelves to be fabricated as specified and as per "Standard Detail".
- J. Fire Retarding:
 - 1. Where required by code, all required materials are to be treated with fire retardant chemicals to achieve the required flame spreading performance rating. Retardant chemicals must be a type approved by local authorities.

2.6 FILTER EXHAUST HOODS AND/OR WATER WASH VENTILATOR FABRICATION:

- A. 18 Gauge (1.3 mm) type 201 or 304 stainless steel external welded construction, in accordance with the latest edition of N.F.P.A. No.96 and International Mechanical Code, including all applicable appendices. Exposed welds to be ground and polished. Exhaust hoods to be U.L. Listed as available for length specified.
- B. Furnish type of fixture specified. Fixtures to be U.L. listed for cooking equipment exhaust hoods, N.S.F. approved, and with sealed safety lenses.
- C. Furnish welded stainless steel formed duct collars at ceiling or wall duct connections. Verify size and location of duct connections required in this contract, before fabrication.
- D. Pre-piped liquid chemical or water fire suppressant system, as specified; complying with applicable local and N.F.P.A. regulations. Wet chemical fire suppression systems to comply with UL 300 Standards. Water fire suppression systems to comply with U.L. Category Subject 199E. Each pull station is to be clearly identified with a permanent type label, as to which exhaust hood(s) it is for. Each exhaust hood is to have a matching permanent type label, identifying which pull station activates its fire system.
- E. All cooking equipment below exhaust hoods/ventilators, on casters, are to be provided with positive wheel placement systems for the rear casters, similar to Posi-Set units, in compliance with NFPA-17A 5.6.4 and NFPA-96 12.1.2.3.
- F. Water wash or ultra-violet control panel to be by the same manufacture as the ventilator, with time clock control for automatic operation. Provide stainless steel trim strips for recessed control cabinet applications. Provide stainless steel chase for surface mounted control panel, from top of panel to ceiling, full width and depth of panel.

2.7 REFRIGERATION EQUIPMENT:

- A. General:

1. Furnish either single or multiple compressor units, as specified or recommended by the manufacturer for the sizes and variations between connected evaporator loads as indicated.
 2. Furnish units of the capacities indicated, arranged to respond to multiple- evaporator thermostats and defrosting timers. Include coils, receivers, compressors, motors, and motor starters, mounting bases, vibration isolation units, fans, dryers, valves, piping, insulation, gauges, winter control equipment and complete automatic control system.
 3. Refrigerant: Precharge units with type or types recommended by manufacturer for services indicated, with quick-disconnect type connections only where specified, ready to receive refrigerant piping runs to evaporators and (where remote) to condensers. All refrigerant and associated components to comply with the requirements of the Montreal Protocol Agreement. No CFC or HCFC refrigerants or associated components will be permitted on this Project. HFC refrigerants and components are to be used. Contractor is responsible for coordinating these requirements with manufacturers.
 4. Foodservice equipment items included in this Section, with remote refrigerated systems, are to include interconnecting refrigeration lines, sizing, and insulation between components, as per manufacturer's installation instructions, and as determined by this Contractor's Certified Refrigeration Sub-Contractor; and only after a thorough examination of actual site conditions and obstacles which might affect the routing. Routing should be as direct and short as possible and practical. Refer to additional requirements listed in this Section 11 40 00, 1.5 Laws, Ordinances and Standards.
 5. The minimum outdoor operating ambient temperature for design of units is -10 degrees Fahrenheit (-23 Centigrade), or lower as applicable for extreme low local conditions. The maximum indoor design temperature for operation of compressor units is 95 degrees Fahrenheit (35 Centigrade). The maximum outdoor ambient design temperature is to be determined by Contractor with prevailing conditions at mounting location of compressor, such as sun exposure, limited ventilation, high fences/walls, roof color and materials, local climatic extremes, etc.; but in no case is it to be less than 100 degrees Fahrenheit (37.8 Centigrade).
 6. All refrigeration systems with remote condensing units and job-site installed interconnecting refrigeration lines shall be tested to verify that there are no leaks. Leak testing shall be equal to or better than a professionally recognized 48 hour minimum, pressure holding test. If any leaks are detected, they shall be repaired and another leak test preformed; until there are zero leaks detected. A written report of the type test preformed and a step-by-step record of the procedure and readings shall be submitted to the KEC for inclusion in the Operations and Maintenance Data Manuals.
- B. Components:
1. Coils for fabricated refrigerators to have vinyl plastic coatings, stainless steel housings; and be installed in such a manner as to be replaceable.
 2. Provide guards for all refrigeration/freezer fans, with maximum 1/2" mesh.
 3. Remote refrigeration system to be complete with thermostatic expansion valves at the evaporator.
 4. Fabricated refrigerated compartments to be fitted with flush dial thermometers, with chrome plated bezels. Thermometers to be adjustable, and shall be calibrated after installation. Thermometers to have an accuracy of + 2 degrees Fahrenheit (1 degree Centigrade).
 5. Hardware:
 - a. Refrigerator hardware for fabricated refrigerator compartments to be heavy-duty components.

- b. Self-closing hinges.
 - c. Latches to be magnetic edge mount type, unless specified or detailed otherwise.
 - 6. Doors and drawers for walk-in coolers/freezers, and reach-in refrigerated compartments, both fabricated and standard, to be fitted with cylinder locking type latches, and provided with master keys.
 - 7. Provide and install shut-off valves and service port for each compressor, manifold or header, and refrigerated fixture for multiplex and parallel installations to enable service personnel to service one (1) fixture while other fixture(s) connected to the same compressor can continue to operate. Isolation valves for individual fixtures based upon the sizes of the individual pieces.
 - 8. Drawers for refrigerated fabricated compartments shall be complete with heated surround at closing perimeter.
- C. Cold Pans: Ice pans, refrigerated pans and cabinets to be provided with breaker strips, where adjoining top or cabinet face materials, to prevent transfer of cold.
- D. All mechanically cooled custom fabricated or standard buy-out refrigerators with openings in the top for cooling pans, and/or all built-in or drop-in mechanically cooled cold pans are to comply with, and be listed by N.S.F. Standard #7. Contractor is to verify that the specified unit complies with this requirement.
- E. Ventilation of Refrigerated Equipment:
 - 1. Adequate ventilation to be provided for custom fabricated equipment with integral refrigeration condensing units, both built-in and drop-in. If flow through ventilation cannot be provided, provide flow direction partitions and an additional fan capable of cooling the condensing unit.
 - 2. If, in the opinion of the Contractor, additional room ventilation is required to ensure correct operating temperatures of standard buy-out, custom fabricated, or remote refrigeration condensing units, or compressor rack assemblies, they are to so state in a letter to the Architect, for evaluation and decision.

2.8 REMOTE REFRIGERATION SYSTEMS

- A. All remote refrigeration systems shall be furnished and installed by one contractor, unless otherwise specified. Provide all components necessary for a complete and operable system. System to be fully capable of satisfying the refrigeration requirements for each fixture as defined by the manufacturer of each fixture.
- B. Compressor and Condensing Units:
 - 1. Units shall be factory assemblies complete with hermetic units below 1 HP, semi-hermetic units 1 HP and larger, air or water cooled condenser, depending upon building conditions and specifications, high-low pressure controls, suction accumulator on low temperature system, sight glass, liquid line dryer, suction and discharge service valves, liquid receiver, and electric control panel. The electrical control panel shall be furnished with magnetic motor starter, defrost timer clock, and contractors in accordance with "Refrigeration Schedule". Compressor capacities shall be based on Air Conditioning and Refrigeration Institute (A.R.I) Standards. The refrigerant for medium and low temperature fixtures to be CFC free and conform to the Montreal Protocol Agreement.
 - 2. Capacities shall be based on the following:
 - a. Compartment temperature and evaporating temperature greater than 32°F (0°C) 18 to 20 hours operations.
 - b. Compartment temperature greater than 32°F (0°C) and evaporating temperature less than 32°F (0°C) 16 hours operation.

- c. Compartment temperature and evaporating temperature less than 32°F (0°C) 18 hours operation.
 3. Condensing units shall be mounted on a steel base to effect a quiet operation. All rotating parts to be carefully balanced for minimum vibration and lubricated with forced or splash oil system. Receiver shall be sized for a complete pump down of the system and shall be shell type with fusible plug.
 4. Compressor units to be provided with suction and discharge back setting type service valves and standard machinery finish.
 5. Motors shall be single speed, maximum 1750 R.P.M. compound wound ball bearings or sleeve bearing. Double squirrel cage motors with high starting torque set and low starting current to be used in a 3 phase application.
 6. All machines to be equipped with quick acting type high-low pressure control switches having adjustable range and differential and high pressure cut-out. Cut-out to be automatic reset type.
 7. For air-cooled units the condenser shall be a standard manufactured part of the equipment. Condensing temperatures shall be based upon (100°F 38°C) ambient air.
 8. Other components and accessories, such as suction filter and crank case heater shall be furnished when specified in the itemized specifications.
- C. Motor Starters-Contactors:
1. All single phase motors shall be provided with mounted and internally wired contactors, except where pre-wired units are furnished without contactors. Single phase compressors shall be provided with built-in thermal and electrical overload protection.
 2. All three phase motors shall be provided with magnetic type starters with quick trip overload elements matched for motor amperage except where overload protection is built into the compressor motor and the manufacturer supplies a contactor instead of a starter. Overload heater element shall be sized according to manufacturer's recommendations. Compressor motor starters shall be definite purpose starters with manual reset.
 3. Starters shall be installed upon surfaces free from excessive vibrations.
 4. Where starters are required for installation in a motor control center, make and model of control center shall be verified and starters provided to match.
- D. Oil Separator
1. Provide oil separators, except when Compressor Manufacturer requires otherwise, 34°F, (1°C) and below and install as near as possible to the compressor. The return line shall be connected to the top of the crankcase above the oil level. Where compressor does not have connection for oil return line from separator, connect to a tee in the suction line adjacent to the compressor. Exposed oil return line to be provided with shut-off valve of the packless stem type.
- E. Compressor Racks:
1. Racks shall be of the number of tiers and quantity to accommodate the number of condensing units specified for each rack assembly and allow for service clearance and ventilation. Review and confirm access into building or housing requirements to roof top locations.
 2. Racks shall be fabricated with structural steel of size and quantity to properly support the equipment to be installed on the rack. In special applications where building access is limited, construct rack framing with Dexion of Unistrut material.
 3. Racks shall be all welded construction with welds ground smooth.
 4. After completion of fabrication the complete rack shall be cleaned, primed and

5. painted with top quality oil base enamel.
 6. Each rack shall be equipped with a pre-wired duplex outlet.
 7. Racks shall be pre-wired to a circuit breaker panel and pre-plumbed to a header (when specified water cooled) requiring a single point electrical and plumbing connection.
 8. Racks shall have UL or equivalent approval.
 9. Special Conditions: For custom built racks for individual condensing units provide Dixon Angle Iron.
- F. Coils and Cooling Units:
1. Units shall be direct expansion type of size and design to effect required temperature, humidity and to suit application intent.
 2. Units shall be hung from the ceiling with 1/2" nylon rods with plated steel nuts and washers. Rods shall extend through ceiling to bracing adequate for the suspended weight. Bracing shall be furnished as required; penetrations shall be sealed and trimmed with escutcheon plates.
 3. Units shall be installed tight to ceiling. All installations adjacent to walls shall be set out a minimum distance conforming to manufacturer's directions, to ensure proper air circulation and performance.
 4. Units with fan or blower and motor shall have thermal overload protection and be wired as indicated in "Refrigeration Schedule".
 5. Defrost cycle shall be based on the following:
 - a. Coils for 32°F (0°C) and lower shall have an electric defrost controlled by a time clock mounted on the compressor rack or at evaporators locations inter-wired by Division 26 - Electrical.
 - b. Coils for 33°F (0.6°C) and 34°F (1°C) shall have an air defrost controlled by a time clock mounted on the compressor rack or at evaporators locations inter-wired by Division 26 - Electrical.
 - c. Coils for temperature above 34°F (1°C) shall have an air defrost in the off cycle controlled by proper sizing of the coil and the compressor.
 6. Location of coils shall be coordinated with shelving and floor sink locations.
 7. All coils for fabricated refrigerators and/or freezers shall be installed for accessibility and replacement.
- G. Penetration Sleeves and Plates:
1. Service line penetrations of insulation to accommodate electrical conduit, refrigerant and drain lines shall be limited to a minimum with service stubbed through insulation or locations predetermined by respective divisions.
 2. Where service lines penetrate insulated walls, the opening shall be packed with caulking, before trimming with escutcheon plate.
 3. Where service lines penetrate building walls outside of foodservice areas, the opening shall be packed with "Perma-Gum" and foam caulking.
 4. All exposed ends of sleeves, both inside and outside of compartments, are to be trimmed with 24 gauge stainless steel escutcheon plates, furnished as blanks in which respective work divisions shall cut required line holes and install.
- H. Refrigerant Piping:
1. Copper tubing for refrigerant piping shall conform to ASTM standard specifications, serial designation B-88. All piping shall be type "L" ACR hard copper or cleaned and sealed soft type "L" tubing, dry seal or equal as indicated. Forged or wrought copper fitting with sweat or soldered joints shall be used.
 2. Tubing shall be cut only with a tube cutter and sized with a sizing tool.
 3. Piping shall be exposed to view as required by the standard safety code for mechanical refrigeration.

4. The liquid suction lines from condensing units to coil shall be sized and run as shown on the "Refrigeration Schedule" and Refrigeration Drawings.
 5. Piping run within cold storage rooms shall be finished with aluminum paint.
 6. For exposed areas, accessible furred ceiling spaces and in walls or excavated trench type installations, hard copper tubing shall be used. Exposed tubing shall be run in a manner to preclude damage by activities in the area; or shall be protected by conduit, furnished and installed as part of this contract. Conduit shall have water evacuated and both ends completely sealed.
 7. For piping run in conduit through inaccessible areas, such as under slab on grade, continuous one piece soft copper tubing shall be used with no joints. In lieu of large piping in conduit, especially vertical runs, random lines may be used; carefully fabricated and assembled to ensure equal pressure drop.
 8. Ends of lines shall be capped to prevent contamination and opened only at time of final connection.
 9. Suction lines shall be sized for a maximum pressure drop from evaporator to compressor 2 lbs. (0.9 kg.) for high and medium temperature systems, and of 1 lb. (0.45 kg.) for low temperature systems and shall allow gas velocities of not less than 750 FPM (3.8 M/sec.) in horizontal runs and 1500 FPM (97.6 M/sec.) in vertical risers. Liquid lines shall be sized for a maximum pressure drop of 3 lbs. (1.36 kg.) from receiver to evaporator.
 10. Tubing runs shall be graded or pitched to prevent trapping of oil. Suction lines shall pitch 1/2"/10"-0" minimum.
- I. Joints and Connections:
1. Fittings shall be long radius wrought copper only as manufactured by Mueller Brass Company or equal.
 2. Vertically run suction lines shall have one piece of manufactured oil "P" traps. Line to be sized for proper velocity for oil return to compressor(s).
 3. 1/8" NPT by 1/4 fl. half union for all suction and discharge service valves with 1/4 fl. cap.
 4. Reduction in piping size shall be made with a manufactured reducer coupling.
 5. Flare nuts shall be short forged or frost proof.
 6. All surfaces to be joined must be prepared and cleaned. When soldering stop or solenoid valves, wrap valves with moist fabric to absorb excessive heat. Stop valves shall be partly open. When soldering expansion valves or pressure regulating valves, remove power assembly, if necessary, to prevent damage by excessive heat.
 7. Copper joints shall be made with Handy & Harmon "Sil-Fos" brazing alloy, "Phoson 15", "Silvaloy 15" or equal; melting point of 1185-1350^oF; (640^oC. - 732^oC.) Silver content not less than 15%.
 8. Copper to brass joints shall be made with Handy & Harmon "Easy Flo 45" brazing alloy "Silvaloy 45", "Mueller 122" or equal; melting point of 1125-1145^oF, (607^o-618^oC.) silver content not less than 45%.
- J. Hangers and Supports:
1. For all piping not run in conduit, provide adjustable hangers, anchors or straps as required. Hanger spacing shall not exceed 8'-0".
 2. Insulated copper piping shall be provided with approved type sleeves at hanger points.
 3. All insulated copper piping shall be isolated from supports by means of felt wrapping or with "Trisolater" by Semco or approved equal.
 4. Vertical piping shall be supported at intervals with spring type hangers or a substantial pipe at case of the pipe. All horizontal pipe runs connected to vertical risers must be adequately supported.
 5. For suspended conduit, support shall be by means of hanger permitting screw

adjustments. Sufficient hangers shall be used to provide support, allow expansion and limit vibration.

- K. Piping Sleeves:
1. Coordinate sleeves provided by the General Contractor through walls which allow for fully insulated lines. Extend sleeves entirely through wall and dress each end with a chromium plated wall plate neatly fitted against the wall, securely fastened and sealed in place. All sleeves through wall shall be of standard weight steel pipe.
 2. Piping lines and sleeves at wall or floor penetrations shall be caulked and made vermin-proof at all locations.
- L. Piping Insulation:
1. Suction lines run in conduit shall be insulated according to ambient and humidity conditions to prevent condensation and freezing.
 2. Refrigeration suction lines outside of refrigerated compartments, not run in conduit, shall be insulated back to compressors with Armstrong Armaflex AP foamed plastic insulation or as determined by code. Thickness of material shall suit service, ambient and humidity conditions, to prevent condensation, minimum thickness 1/2" (15 mm.).
 3. Cold Storage Room freezer drain lines extended through adjacent cooler compartments shall be insulated with 1/2" (15 mm) minimum thickness of Armstrong Armaflex AP foamed plastic insulation to prevent condensation. Carefully seal end of insulation tight against cooler wall surface.
 4. Piping for cooling water services or refrigerant piping exposed to freezing ambient temperatures shall be insulated with 1/2" (15 mm) minimum thickness of Armstrong Armaflex AP foamed plastic insulation. Paint exterior installation with Armaflex paint.
 5. Thickness of material shall suit service, ambient and humidity conditions to prevent condensation.
 6. Joints shall be sealed with Armstrong 520 adhesive. Insulation shall be continuous through clamps. Provide additional insulation where suction lines must be run within 12" or less of water or underground waste lines.
 7. Exterior-run piping shall be insulated as per above and covered with stainless steel channels secured to structure, sealed to be weather-proof.
- M. Heat Interchangers:
- All blower controls, unit coolers, plate type evaporators and other evaporators where specified, are to be provided with heat interchangers, with a capacity to match the condensing unit.
- N. Temperature Control:
1. Temperature control of cold storage rooms shall be by line voltage thermostats operating liquid line solenoids.
 2. Temperature control for remote normal temperature refrigerator shall be by low pressure switch setting.
 3. Temperature in each cold storage room compartment shall be controlled by electric thermostat, Ranco No. 010-1408, located within compartment and sensing element positioned to avoid fan discharge air stream.
 4. Contractor to coordinate any additional specified temperature control/monitoring/alarm system within this document set including assisting with coordination of home-run control wiring, wireless assembly coordination and HACCP requirements in terms of reporting.
- O. Valves and Accessories:

1. All valves and controls shall be standard weight and suitable for service purpose intended, and subject to approval by the Designer.
2. Provide shut-off valves and service port for each refrigerated fixture for multiplex installations to enable service personnel to service one (1) fixture while other fixture(s) connected to the same compressor can continue to operate.
3. Each system shall include condensing unit with standard valving, refrigerant piping, refrigerant, evaporator(s), liquid and suction line isolation valves within 5'-0" (1500 mm) of evaporators, thermostatic expansion valve for evaporator, heat exchanger, filter-dryer, liquid line solenoids for Cold Storage Rooms and liquid indicator.
4. Vibration eliminators on compressor suction and discharge lines, size same as piping, as manufactured by Anaconda.
5. Refrigerant shut-off valves shall be as manufactured by Henry or Superior Valve Company. Valves shall be placed in liquid line for each condensing unit and in each liquid line to each evaporator.
6. Expansion valves shall be Sporlan, or approved equal, furnished and installed in the liquid line at the evaporator, unless provided with manufactured equipment. External equalizer expansion valves shall be provided for coils fitted with refrigerant distributor.
7. A Sporlan, or approved equal, drier shall be provided at the compressor. Up to 3HP shall be a Catch-All series; larger than 3HP shall be angle replaceable cartridge series, or approved equal.
8. Each liquid line sight glass shall be Sporlan "See All" moisture and liquid indicator and shall be full line size, or approved equal.
9. Solenoid valves shall be Sporlan, or approved equal, line voltage, manual lift stem type, to operate at maximum of 2 lbs. (0.9kg.) pressure drop across the valve. Valves shall be full line size, using silver solder connection as applicable. A liquid line solenoid, normally closed, shall be used with temperature controller for each Cold Storage Room compartment coil on a system.
10. Include a suction line filter with access valve adjacent to compressor. Filter shall be a Superior "F" Series or equal.
11. EPR, CTR, and/or CDA valves shall be Alco or Sporlan, or approved equal.
12. Suction accumulators shall be Refrigeration Research 3700 series or Virginia VA series, or approved equal.
13. Discharge line mufflers shall be Refrigeration Research M-10 and M-15 or AC and RSS- 6300 series, or approved equal.
14. Time clocks shall be Paragon, or approved equal.

P. Drain Lines:

Type "L" copper coil drain lines extended to exterior of refrigerated compartments over floor sinks (drain) with "S" traps at termination ends.

1. Provide clean out "T" and cap at each change of direction in the lines. Provide individual drain lines for each coil unless otherwise specified. Drain lines shall be run tight to refrigeration compartment walls with minimum pitch of 2" per foot.
2. Drain lines inside low temperature compartments shall be equipped with drain-line heaters wired by electrical division. Drain lines in low-temperature compartments shall be extended into adjacent, medium, or high temperature compartments to reduce length of drain line heater required. (Drain line in low temp compartment to be insulated with Armaflex 1/2" – insulation and wall fastening by the foodservice equipment contractor).
3. Drain lines on the exterior of refrigerated compartment shall be painted with chrome tone paint and shall be trapped to disallow ambient air infiltration into

refrigerated cavity.

- Q. Refrigerant/Compressor Oil Reclaim:
1. For existing refrigeration systems which may be reused, abandoned or where site conditions warrant, the system(s) refrigerant, oil and/or other components shall be reclaimed and contained by certified personnel in conformance to Refrigerants and Hazardous Waste criterion as specified by the Environmental Protection Agency and/or Montreal Protocol Guide Lines & Requirements.

2.9 MISCELLANEOUS MATERIALS AND FABRICATION:

- A. Nameplates: Whenever possible, locate nameplates and labels on manufactured items, in accessible position, but not within customer's normal view. Do not apply name plates or labels on custom fabricated work, except as required for compliance with governing regulations, insurance requirements, or operator performance.
- B. Manufactured Equipment Items: Furnish items as scheduled or herein specified. Verify dimensions, spaces, rough-in and service requirements, and electrical characteristics, before ordering. Provide trim, accessories and miscellaneous items for complete installation.
- C. Insert Pans:
1. General: Cut-outs, openings, drawers, or equipment specified or detailed to hold stainless steel insert pans to be provided with a full complement of pans as follows:
 - a. One (1) stainless steel, 20 gauge (1 mm) minimum, solid insert pan – in us pan size or gastronorm configuration as specified for each space, sized per plans, details, or specifications.
 - b. Where pan sizes are not indicated in plans, details, or specifications, provide one full-size pan for each opening.
 - c. Provide maximum depth pan to suit application and space.
 2. Provide 18 gauge (1.3 mm) NSF- approved removable stainless steel adapter bars where applicable.
 3. All cut-outs and openings, or equipment specified or detailed to hold stainless steel insert pans, shall be provided with a hinged stainless steel removable night cover.
- D. Tray Slides: Before fabrication of counters with tray slides, verify:
1. Size and shape of tray with Owner/Operator. Edge of tray should not overhang outer support/slider by more than 2" (50 mm). If edge of tray exceeds this dimension, notify Architect, in writing, for evaluation and adjustment, if necessary.
 2. Configuration of corners, turns, and shape of tray slides for proper support and safe guidance of trays.
 3. Tray slide to be capable of supporting 200 pounds per linear foot (298 kgs/meter), live load.
 4. All tray slides shall be fabricated with a 15 degree turn down 2" in from end of slide to disallow scraping of trays and poly racks.
- E. Self-leveling dispensers: Verify type, make dimensions and weight of ware with Owner/Operator; and submit to the dispenser manufacturer, for proper sizing and calibration of dispensers.

- F. Carbon dioxide (CO₂) equipment: Where equipment requires connection with compressed CO₂ cylinder for operation, provide 2-cylinder manifold and control system (integral with equipment) with proper connectors for Department of Transportation (DOT) approved type cylinders, complete with cylinder safety devices and supports. Applicable to projects with CO₂ equipment included in Contractor's specified equipment.
- G. Reasonable quietness of operation of equipment is a requirement, and Contractor will be required to replace or repair any equipment producing out-of-the-ordinary intolerable noise. This also includes providing and installing bumpers and gaskets for doors and drawers on fabricated and standard manufactured items and sound insulation where feasible.
- H. Gas pressure regulator: All gas fired equipment included with this Section is to be provided with a gas pressure regulating valve with a built-in vent limiting device sized per WC pressure rating of this project. Contractor is responsible for coordinating this requirement with their manufacturers and suppliers.

PART 3 – EXECUTION

3.1 SUPERVISION:

- A. A competent supervisor, representing the Contractor, is to be present at all times during progress of the Contractor's work.
- B. Contractor is responsible for coordinating with all applicable Design Team members, Key Ownership Stakeholders Assigned, General Contractor, other Contractors and/or Sub-Contractors and Trades involved in this Project and associated with any items or work provided under this Section; as required for the successful provision, installation, completion, and functioning of these items and/or work, and the Project in general. This is to include, but not be limited to, exchange of shop drawings, details, and manufacturer's information, supplying templates or actual components to be installed in or on items provided by other Sections, for coordination; and coordinating with and between their own internal staff, sub-contractors, trades, manufacturers, fabricators and installers, for compliance with the Contract Documents.
- C. Contractor responsible for obtaining any documents referenced in this Section and on any associated drawings, which contain information relative to the performance of this Contract; and disseminating and coordinating the pertinent information contained in them, with the appropriate sub-contractors, manufacturers, fabricators, and/or installers.
- D. Contractor is to take every precaution against injuries to persons or damage to property.
- E. Contractor is to store his apparatus, materials, supplies and equipment in an orderly fashion at the site of the work so it will not unduly interfere with the progress of his work or the work of any other contractors.

3.2 SITE EXAMINATION:

- A. Verify site conditions under the provisions of the General Conditions, Supplementary Conditions and applicable provisions of Division 1 Sections. Notify the Architect, in writing, of unsatisfactory conditions for proper installation of foodservice equipment.
- B. Verify wall, column, door, window, and ceiling locations and dimensions. Fabrication

and installation should not proceed until dimensions and conditions have been verified and coordinated with fabrication details.

- C. Verify that wall reinforcement or backing has been provided, and is correct for wall supported equipment. Coordinate placement dimensions with wall construction Section.
- D. Verify that ventilation ducts are of the correct characteristics, and in the required locations.
- E. Verify that utilities are available, of the correct characteristics, and in the required locations.

3.3 DELIVERY AND INSTALLATION:

- A. Delivery:
 - 1. The equipment shall be delivered and installed on schedule. Coordinate all work with the General Contractor and other divisions as required.
 - 2. Deliver materials (except bulk materials) in manufacturer's containers, fully identified with manufacturer's name, trade name, type, class, grade, size, color, item number, area, etc.
 - 3. Contractor is responsible for receiving and warehousing equipment and fixtures, until ready for installation. Store materials, equipment and fixtures in sealed containers, where possible. Store off the ground and under cover, protected from damage.
 - 4. Contractor to verify and coordinate conditions at the building site, particularly door and/or wall openings, and passages, to assure access for all equipment. Pieces too bulky for existing facilities are to be hoisted or otherwise handled with apparatus as required.
 - 5. Extra charges resulting from special handling or shipment to be paid by the Kitchen Equipment Contractor if insufficient time was allowed in placing factory orders to ensure normal shipment.
- B. The work to be accomplished so as not to delay the project construction schedule, interfere or conflict with the work being performed by other contractors. Work to be coordinated and integrated to prevent conflict of work necessitating changes to work already completed. Sequence installation and erection to ensure correct mechanical and electrical utility connections are achieved.
- C. Verify all field dimensions before fabrication.
- D. Install items in accordance with manufacturer's instructions.
- E. Set each item of non-mobile and non-portable equipment securely in place, leveled and adjusted to correct height. Anchor to supporting substrate where indicated, and where required for sustained operation and use without shifting or dislocation. Conceal anchorages wherever possible. Adjust counter tops and other work surfaces to a level tolerance of 1/16" (1.6 mm) (maximum offset, and plus or minus on dimension, and maximum variation in 24" (610 mm) run from level or indicated slope). Provide anchors, supports, bracing, clips, attachments, etc., as required to comply with the local seismic restraint requirements. The Guidelines for Seismic Restraint of Kitchen Equipment, as prepared for the Sheet Metal Industry Fund of Los Angeles and endorsed by S.M.A.C.N.A., is to be followed.
- F. Complete field assembly joints in the work (joints which cannot be completed in the shop) by welding, bolting-and-gasketing, or similar methods as indicated and specified.

- Grind welds smooth and restore finish. Set or trim flush, except for "T" gaskets as indicated. Field joints shall not be visible to the untrained eye.
- G. Provide closure plates and strips where required, with joints coordinated with units of equipment.
 - H. Provide sealants and gaskets all around equipment to wall, ceiling, floors, masonry pads, and adjoining units not portable and with enclosed bodies to make joints airtight, water- proof, vermin-proof, and sanitary for cleaning purposes. Space between all equipment to wall, ceiling, floors, masonry pads, and adjoining units not portable and with enclosed bodies to be shall be completely sealed against entrance of food particles or vermin by means of trim strips, welding, soldering or mastic. Mastic to be General Electric Silicone Construction Sealant Series SE1200 or equal in appropriate color.
 - I. Joints up to 3/8" (9.5 mm) wide, to be stuffed with backer rod, to shape sealant bead properly, at 1/4" (6 mm) depth.
 - J. At internal corner joints, apply sealant or gaskets to form a sanitary cove, of not less than 3/8" (9.5 mm) radius.
 - K. Shape exposed surfaces of sealant slightly concave, with edges flush with faces of mate- rials at joint.
 - L. Provide sealant filled or gasketed joints up to 3/8" (9.5 mm) joint width. Wider than 3/8" (9.5 mm), provide matching metal closure strips, with sealant application each side of strips. Anchor gaskets mechanically, or with adhesives to prevent displacement.
 - M. Treat enclosed spaces, inaccessible after equipment installation, by covering horizontal surfaces with powdered borax at a rate of 4 ounces per square foot (1.2 kg/m²).
 - N. Insulate to prevent electrolysis between dissimilar metals.
 - O. Cut and drill components for service outlets, fixtures, piping, conduit, fittings, etc. as re- quired. Grind and polish penetrations to safe tolerance. Work to include welded sleeves, collars, ferrules or escutcheons.
 - P. Verify and coordinate the mounting heights of all wall shelves and equipment, with equipment located below them, for proper clearances.
 - Q. Walk-In Cooler/Freezers:
 - 1. The cold storage rooms shall be delivered and installed on schedule by factory supervised and approved installers. Coordinate the work with the General Con- tractor and other trades as necessary.
 - 2. Provide the necessary job site coordination with the various trades to insure job site conditions will meet the requirements of the cold storage rooms.
 - 3. During curing and cleaning of the wearing floors inside the cold storage rooms, the cold storage room doors shall be left open and the rooms well ventilated to prevent damage to the interior. "Keep Out" signs to be posted at each open door.
 - 4. After the installation of the cold storage rooms and prior to the installation of the wearing floor has cured, the cold storage room doors are to be closed and locked.
 - R. Coordinate with the Plumbing and Electrical Divisions, and provide penetrations in food

service equipment for plumbing and electrical service to and through the fixtures, as required. This includes welded sleeves, collars, ferrules, or escutcheons. These services are to be located so that they do not interfere with intended use and/or servicing of the fixture.

- S. All equipment provided by this Section, that requires light bulb(s), are to be provided with heavy-duty, energy efficient, extra long life bulbs with a minimum life expectancy of 5000 hours, and as required by the local Jurisdictions. All light bulbs in and/or above foodservice equipment and/or areas are to be coated or provided with shields in compliance with local health codes.
- T. All equipment provided by this Section, shall include any and all parts, components, options, accessories, etc. necessary to provide a completely functional item for its intended use under normal conditions; and if appropriate, after the final utility connections are completed by other Divisions. This shall generally apply to equipment such as soda systems, beer systems, and remote refrigeration systems, any type remote system or equipment, or ice machines; but shall also apply to any equipment provided by this Section.

3.4 COUNTERTOP INSTALLATION:

- A. General: Install countertops, except for vanities, over plywood sub-tops with a full spread of water-cleanable epoxy adhesive.
- B. Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
 - 1. Tops:
 - a. Flat and true to within 1/8" of a flat surface over a 10' length.
 - b. Allow a minimum of 1/16" to a maximum of 1/8" clearance between surface and each wall.
- C. Fit countertops around projections and to adjacent construction. Smooth and clean field cut edges. Ensure that trim will completely cover cut edges.
- D. Bond seams with stone seam adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to seams to prevent adhesive smears. Use clamps to ensure countertop units are properly aligned and seams are minimum width.
- E. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts while cutting to prevent damage.
- F. Install backsplash and end splash by adhering to wall with water-cleanable epoxy adhesive.
- G. Leave 1/16-inch gap between countertop and splash for filling with sealant. Use temporary shims to ensure uniform spacing.
- H. Heat isolation for hot food wells, heated deck and other drop-in heated equipment.
 - 1. Three (3) layers of Nomex insulation held in place with aluminum tape.
 - 2. 16 gauge stainless steel collar.
 - 3. Heat resistant, food safe silicone caulking.
- I. Apply sealant to seams and to gap between countertops and splashes; comply with Section 07 92 00 (07920) "Joint Sealants."

- J. Countertop Adjusting and Cleaning:
1. Remove and replace or repair stonework of the following description:
 - a. Broken, chipped, stained, or otherwise damaged stones. Broken, chipped, stained, or otherwise damaged stone may be repaired, providing the methods and results are acceptable to Owner's Representative.
 - b. Defective joints.
 - c. Stones and joints not matching approved samples.
 - d. Stonework not complying with other requirements indicated.
 2. Replace in manner that results in stonework matching approved samples and field-constructed mock-ups, complying with other requirements, and showing no evidence of replacement.
 3. The Contractor is to clean the stone countertops not less than six days after completion of work, using clean water and stiff and soft rags. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage the stone.
- K. Countertop Sealer Application:
1. All surfaces must be clean and free from all loose grit and debris, satins, dirt, and wax coatings. Surfaces shall remain dry for a minimum of 24 hours before the application of sealer and remain dry for 24 hours after the application of sealer.
 2. Floor surface temperature must be above 50° F. and below 90° F.
 3. Test on a small area before using to determine if the product is acceptable with type of stone.
 4. Two (2) uniform coatings of sealer shall be applied before or after installation of stone materials. If prior to installation, adequate documentation shall be included with the material confirming it has been sealed. If after installation, install in strict accordance with Sealer manufacturer's recommendations.

3.5 PROTECTION OF WORK:

- A. Use all means reasonable to protect the materials of this Section against theft and damage before, during, and after installation; and to protect the associated work and materials of the other trades.
- B. Fabricated fixtures: cardboard, fiberboard or plywood taped to tops and exposed body panels/components.
- C. Manufactured Equipment: cardboard, fiberboard or plywood taped as required by equipment shape and installation-access requirements.
- D. Prohibited use of equipment includes tool and materials storage, workbench, scaffolding and stacking of construction materials.
- E. Damaged Equipment: immediately document and submit to Owner with Contractor's recommendation of action for repair or replacement and its impact on the Project Schedule and Contract Amount.
- F. Pre-fabricated walk-in coolers/freezers are not to be used as general storage; and should be locked before leaving the site daily. Damage and theft resulting from failure to secure units will be repaired or replaced at Contractor's expense.

3.6 ADJUSTING:

- A. Equipment to be tested for leaks, poor connections, inadequate or faulty performance.
 - 1. Thermostatically controlled equipment and equipment with automatic features shall be operated for 14 days to prove controls are functioning as intended. Walk-in refrigerators and freezers shall be turned on and ran for a minimum of fourteen days.
- B. Refrigeration equipment to run a minimum of three days duration before acceptance.
- C. Lubricate and adjust drawer slides, hinges, casters.
- D. Adjust pressure regulating valves, timed-delay relays, thermostatic controls, temperature sensors, exhaust hood grilles, etc.
- E. Clean or replace faucet aerators, line strainers.
- F. Repair, adjust or replace equipment which is found to be defective in its operation, including units which are below capacity or operating with excessive noise or vibration.

3.7 CLEANING, RESTORING AND REPAIRING:

- A. After completion of installation, and completion of other major work in foodservice areas, remove protective coverings and clean foodservice equipment, internally and externally. Repair all damage as a result of this installation.
- B. Restore exposed and semi-exposed finishes removing abrasions and other damages; polish exposed metal surfaces and touch-up painted surfaces. Replace work, which cannot be successfully restored.
- C. Polish glass, plastic, hardware and accessories, fixtures and fittings.
- D. Wash and clean equipment, and leave in a condition ready for the Owner to sanitize and use.

3.8 TESTING:

- A. Delay the start-up of equipment until service lines have been tested, balanced, and adjusted for pressure, voltage and similar considerations; and until water and steam lines have been cleaned and treated for sanitation.
- B. Kitchen Equipment Contractor (K.E.C.) with assistance from a factory-certified representative from the exhaust hood manufacturer shall conduct an exhaust hood performance test for each exhaust hood in the K.E.C.'s scope of work at the conclusion of the project when all hoods and related cooking equipment are in operation. K.E.C. shall have manufacturer's factory authorized representative test and measure exhaust airflow rates, dampers, switches, and sequence of operation, with all appliances at operating temperatures. K.E.C. shall furnish a written report within ten (10) working days of substantial completion and acceptance of the project by the Owner, indicating the design requirements for each hood and the actual operating parameters as tested and measured.
- C. Refrigeration Piping Testing:
 - 1. Each system shall be pressure tested for leaks. Tests for to be on the high side and on the low side. All valves shall be fully open during last test.
 - 2. Tests are to be accomplished as follows:

- a. Charge the systems with refrigerant through the port of liquid shut-off valves of the receivers to a pressure of 10 to 20 p.s.i.
 - b. Add dry nitrogen, the supply of which shall be equipped with a pressure regulating valve to provide the specified pressure.
 - c. Carefully test all joints for leaks using either a Halide torch or an electronic Halogen leak detector.
3. Precautions to be taken to disconnect the low pressure controls for protection of the bellows during testing.
 4. Refrigeration System Evacuation:
 - a. Evacuation shall be with a vacuum pump with an indicating gauge registering pressure in microns. Pump shall be connected to the system with a 5/8" (15 mm) O.D. line or larger.
 - b. Evacuate both high and low sides to 500 microns. Break the vacuum with refrigerant to 0 p.s.i. evacuate high and low sides to 100 microns; and then break vacuum to 0 p.s.i. with the refrigerant to be used in the system.

3.9 START-UP AND INSTRUCTIONS:

- A. Make arrangements for demonstration of foodservice equipment operation and maintenance, in advance with the Owner/Operator.
- B. Demonstrate foodservice equipment, to familiarize the Owner and the Operator on operation and maintenance procedures, including periodic preventative maintenance measures required. Include an explanation of service requirements and simple on-site service procedures, as well as, information concerning the name, address and telephone number of qualified local source of service. The individual(s) performing the demonstration are to be knowledgeable of operating and service aspects of the equipment.
- C. Provide a written report of the demonstration, to the Owner, outlining the equipment demonstrated and malfunctions or deficiencies noted. Indicate individuals present at demonstration.
- D. Final Cleaning: After testing and start-up, clean the foodservice equipment, and leave in a condition ready for the Owner to sanitize and use.
- E. All keys for all locks provided with equipment provided under this Section, are to be gathered up, individually tagged with the equipment they belong to, put into a single box, and handed over to the Owner's authorized representative. A list of the keys and their associated equipment Item numbers is to be provided with the O&M Manuals, along with a copy of the list, signed by the Owner's representative, acknowledging receipt of the keys.

3.10 CLEAR AWAY

- A. Throughout the progress of their work, Contractor is to keep the working area free from debris, and remove rubbish from premises resulting from work being done by them. At the completion of their work, Contractor is to leave the premises in a clean and finished condition.

3.11 REUSED EXISTING EQUIPMENT:

- A. Contractor is responsible for identifying, tagging and/or removing all existing equipment, which will be reused. Verify and coordinate specific equipment with these plans and

specifications, and the Owner. This includes items existing, and the associated work necessary, at the time of the signing of the Contract for the Foodservice Equipment section; and does not include any items added, changed, or damaged (by other than the Contractor) after the signing; except to the extent of work which would have been included with the original existing items.

- B. Remove from existing locations, clean and renovate as noted below, store and re-install existing equipment to be reused, in the new locations as shown on plans; ready for utility connections, as appropriate. Existing equipment to be reused, with utility connections, to be removed after disconnection as noted in paragraph J, below.
- C. Do work in cooperation with Owner, so that normal functioning of services is minimally interrupted. Coordinate all removal and replacement scheduling with the Construction Scheduling Manager (or similar responsible party), to insure adequate time to complete the necessary work. If adequate time to properly relocate and reset the existing items, and complete all cleaning and repair will not be available, due to continuing use of the existing items, or the allotted construction time; contact the Owner and obtain a written agreement as to what work is to be deleted or delayed; such as cleaning, repainting, or re-pairs.
- D. All surface dirt, grease, oil, food residues, ingredients, extraneous matter and other soiling materials is to be removed in order to obtain minimum acceptable sanitation and food service standards. Thorough final rinsing of all cleaning agents to be at a minimum temperature of 180 degrees Fahrenheit (82.2 Centigrade) where possible without damage to equipment or controls. Otherwise, use USDA approved cleaning agents and/or cleaning agents, which are acceptable for use with commercial food service equipment. This includes all exterior surfaces of the existing equipment to be reused, and interior work surfaces such as inside oven compartments, fryer vats, ware washers, etc.
- E. All painted items with major paint blemishes to be sanded, primed, and repainted to match the original color and type paint. Primer and paint to be of a type approved for use with commercial food service equipment. All controls, lights, view windows, non-painted parts, etc. to be protected as recommended by the Manufacturer. Minor paint blemishes can be touched-up in a professional manner. This work is to be included in the Bid Submittal, as a separate line cost, at the end of the Bid Submittal.
- F. Replace and/or repair minor broken parts to produce a cleanable and functional item. Re-pairs and/or parts are for minor required items such as control knobs, handles, pilot lamps, belts, oil changes, minor adjustments and recalibrations, etc. This does not include addition or replacement of any wearing components such as cutters, blades, etc.; or any accessory components such as mixer beaters, hooks, whips, etc., except for presently existing accessory components which are broken and non-functional, or as noted in the itemized specifications.
- G. Where required by local code authorities, provide additional parts and/or modifications to comply with code requirements in place at the time of this project.
- H. Where required, remove reused existing equipment from the premises for repairs, alterations and cleaning.
- I. Refer to schedule on the Foodservice Drawings and to the Itemized Specifications at the end of this section, for reused existing equipment.
- J. Disconnection of existing equipment to be relocated and/or reused and disconnection and removal/disposal of existing equipment, which will not be reused, is work as

designated by the Architect, and not included in this Section. (See page 11 40 00-2, 1.3.F.)

- K. Cost estimates for any repairs and/or parts more than the minor items stated above, or re- pairs requiring significant disassembling of the item, should be submitted to the Owner, for consideration and approval as an addition to the Contract. In general, this would be considered as any repairs and/or parts amounting to an estimate up to 10% of the cost of a comparable new item. Any item, which would require repairs and/or parts amounting to an estimate up to 25% or more, should include an alternate cost for supplying a comparable new item as a consideration by the Owner, and addition to the Contract. Estimates are for each individual reused existing item only, which requires repairs and/or parts, and on- ly to the extent that work is actually required; and should not be considered as a lump sum estimate on all reused existing items combined, or as an allowance for adding accessories or options.

3.12 ITEMIZED SPECIFICATIONS:

- A. Specific information on each item will be-ADDED in this section.

END OF SECTION 11 40 00

SECTION 11 52 13 - PROJECTION SCREENS

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. Manually operated, front-projection screens.
 - 2. Electrically operated, front-projection screens and controls.
- B. Related Requirements:
 - 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood backing for screen installation.

1.3 DEFINITIONS

- A. Gain: Ratio of light reflected from screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94.
- B. Half-Gain Angle: The angle, measured from the axis of the screen surface to the most central position on a perpendicular plane through the horizontal centerline of the screen where the gain is half of the peak gain.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show layouts and types of front-projection screens. Include the following:
 - 1. Drop lengths.
 - 2. Location of seams in viewing surfaces.
 - 3. Location of screen centerline relative to ends of screen case.
 - 4. Anchorage details, including connection to supporting structure for suspended units.
 - 5. Details of juncture of exposed surfaces with adjacent finishes.
 - 6. Location of wiring connections for electrically operated units.
 - 7. Wiring diagrams for electrically operated units.
 - 8. Accessories.
- C. Samples for Initial Selection: For finishes of surface-mounted screen cases.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For front-projection screens to include in maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Environmental Limitations: Do not deliver or install front-projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 COORDINATION

- A. Coordinate layout and installation of front-projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC equipment,[fire-suppression system,] and partitions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Projection Screens: Obtain screens from single manufacturer. Obtain accessories, including necessary mounting hardware, from screen manufacturer.

2.2 MANUALLY OPERATED, FRONT-PROJECTION SCREENS

- A. General: Manufacturer's standard spring-roller-operated units, consisting of case, screen, mounting accessories, and other components necessary for a complete installation.
 - 1. Screen Mounting: Top edge securely anchored to a 3-inch- (75-mm-) diameter, rigid steel roller; bottom edge formed into a pocket holding a tubular metal slat, with ends of slat protected by plastic caps, and with a saddle and pull attached to slat by screws.
- B. Bracket-Mounted or Surface-Mounted or Ceiling-Suspended, Metal-Encased, Manually Operated Screens with or without Tab Tensioning: Units fabricated from formed-steel sheet not less than 0.027 inch (0.7 mm) thick or from aluminum extrusions; with vinyl covering or baked-enamel finish and matching end caps. Provide mounting brackets unless otherwise indicated.
 - 1. Manufacturers:
 - a. Draper
 - b. Stewart
 - c. Equal product approved by Architect in an addendum.

2.3 ELECTRICALLY OPERATED, FRONT-PROJECTION SCREENS

- A. General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Electrical Components, Devices, and Accessories: Listed and

labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1. Controls: Remote, three-position control switch installed in recessed device box with flush cover plate matching other electrical device cover plates in room where switch is installed.
2. Manufacturers:
 - a. Electrol
 - b. Equal product approved by Architect in an addendum.
3. PROJECTION SCREEN SCHEDULE
 - a. Generic Screen
 - 1) Basis of Design: Da-Lite Tensioned Contour Electrol.
 - 2) Mounting: Wall mounted at 105" AFF.
 - 3) Viewing Area: 57 ½" x 92".
 - 4) Drop: 12" of total drop. (36" AFF to bottom of screen).
 - 5) Video projector interface (Screen Trigger).
 - 6) Screen material: Basis of Design; Da-Lite HD Progressive 1.3.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions.
- B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
 1. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.
 - a. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
 2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
 3. Test manually operated units to verify that screen-operating components are in optimum functioning condition.

END OF SECTION 11 52 13

SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes roller shades and shade operators.
- B. Related Sections include the following:
 - 1. Division 6 Section "Miscellaneous Carpentry" for wood blocking and grounds for mounting roller shades and accessories.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
- B. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.
 - 1. Motorized Shade Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension system members and attachment to building structure.
 - 2. Ceiling-mounted or penetrating items including light fixtures, air outlets and inlets, speakers, sprinklers, recessed shades, and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.
 - 3. Shade mounting assembly and attachment.
 - 4. Minimum Drawing Scale: 1/4 inch = 1 foot (1:48).
- D. Samples for Initial Selection: For each colored component of each type of shade indicated.
 - 1. Include similar Samples of accessories involving color selection.

- E. Window Treatment Schedule: For roller shades. Use same designations indicated on Drawings.
- F. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining roller shades and finishes.
 - 2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
 - 3. Operating hardware.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Source Limitations: Obtain roller shades through one source from a single manufacturer.
- C. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Flame-Resistance Ratings: Passes NFPA 701.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Product Standard: Provide roller shades complying with WCMA A 100.1.
- F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 ROLLER SHADES

A. Manufacturer:

1. The design for roller shades is based on the MechoShade shade materials listed in Part 4 of this section. Subject to compliance with requirements, provide product by MechoShade or a comparable product by one of the following:
 - a. Draper, Inc.
 - b. Lutron Shading Solutions by VIMCO.
 - c. Silent Gliss USA, Inc.

2.2 ROLLER SHADES

A. Shade Band Material: PVC-coated fiberglass and polyester blends.

1. Bottom Hem: Straight.
2. Double Shade.
3. Material Openness Factor: As indicated.
4. Material Color: To match material listed in the Roller Shade schedule in Part 4 of this section.

- B. Rollers: Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with manufacturer's standard method for attaching shade material. Provide capacity for one roller shade band per roller, unless otherwise indicated on Drawings or in a window treatment schedule.

- C. Direction of Roll: Regular, from back of roller.

- D. Mounting Brackets: Galvanized or zinc-plated steel.

- E. Pocket with Ceiling Slot Opening: Six-sided box units for recessed installation; fabricated from formed-steel sheet, extruded aluminum, or wood; with a bottom consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing rollers, brackets, and operating hardware and operators within; capacity for one roller shade per pocket, unless otherwise indicated on Drawings.

- F. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; removable design for access.
- G. Bottom Bar: Steel or extruded aluminum, with plastic or metal capped ends. Provide concealed, by pocket of shade material, internal-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.
- H. Valance: Style matching hem; as indicated by manufacturer's designation color.
- I. Mounting: Recessed in ceiling pocket mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.
- J. Shade Operation: Manual; with continuous-loop bead-chain, clutch, and cord tensioner and bracket lift operator.
 - 1. Clutch: Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
 - 2. Lift-Assist Mechanism: Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.
 - 3. Loop Length: Length required to make operation convenient from floor level.
 - 4. Bead Chain: Nickel-plated metal.
 - 5. Operating Function: Stop and hold shade at any position in ascending or descending travel.
- K. Shade Operation: Motorized operator where indicated.

2.3 ROLLER SHADE FABRICATION

- A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.
- B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
 - 1. Lifting Mechanism: With permanently lubricated moving parts.
- C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
 - 1. Shade Units Installed between (Inside) Jamb: Edge of shade not more than 1/4 inch (6 mm) from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
 - 2. Shade Units Installed Outside Jamb: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting headbox, fascia, roller, and operating hardware and for hardware position and shade mounting method indicated.

- E. Installation Fasteners: Not fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.
- F. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
- G. Colors of Metal and Plastic Components Exposed to View: As selected by Architect from manufacturer's full range, unless otherwise indicated.

2.4 MOTORIZED ROLLER SHADE OPERATORS

- A. General: Provide factory-assembled motorized shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated by roller shade manufacturer. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by shade manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.
- B. Comply with NFPA 70.
- C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
- D. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection, brake, permanently lubricated bearings, and limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.
 - 1. Service Factor: According to NEMA MG 1, unless otherwise indicated.
 - 2. Motor Characteristics: Single phase, 110 V, 60 Hz.
 - 3. Motor Mounting: Within manufacturer's standard roller enclosure.
- E. Position of Motor and Electrical Connection: Left or right side of roller, as determined by hand of user facing shade from inside, as indicated on Drawings.
- F. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following devices for remote-control activation of shades:
 - 1. Control Stations: Keyed, maintained-contact and momentary center off, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
 - 2. Control Stations: Maintained-contact and momentary center off, three-position, rocker-style, wall switch-operated control station with open, close, and center off functions.

3. Group Control Stations Maintained-contact and momentary center off, three-position, rocker-style, wall switch-operated control station with open, close, and center off functions for single-switch group control.
- G. Operating Function: Stop and hold shade at any position.
- H. Operating Features: Include the following:
1. Group switching with integrated switch control; single face plate for multiple switch cut-outs.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow clearances for window operation hardware.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

PART 4 - EXHIBITS

4.1 ROLLER SHADE SCHEDULE

A. Room Darkening Shade

1. Basis of Design: MechoShade - Electro 3.
2. Shade Material: ThermoVeil 0700 Series Room Darkening Shade Cloth / Thermo Veil 3000 Series Parchment 1-2%
3. Operation: Motorized.
4. Color: To be determined.
5. Location: As indicated on the drawings.

B. Mesh Solar Shade – Openness Factor 3% - verify with Owner (unless otherwise shown)

1. Basis of Design: MechoShade - Electro 2.
2. Shade Material: ThermoVeil 1300 Series
3. Openness Factor: - verify with Owner 3%(unless otherwise shown)
4. Operation: Motorized.
5. Color: As indicated on the drawings.
6. Location: As indicated on the drawings.

C. Privacy Shade

1. Basis of Design: MechoShade - Electro 1.
2. Shade Material: ThermoVeil 3000 Series
3. Openness Factor: 5%
4. Operation: Motorized.
5. Color: Parchment.
6. Location: As indicated on the drawings.

END OF SECTION 12 24 13

SECTION 12 36 23.13 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

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. Plastic-laminate-clad countertops.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings: For plastic-laminate-clad countertops.
 - 1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
 - 2. Show locations and sizes of cutouts and holes for items installed in plastic-laminate-clad countertops.
 - 3. Apply AWI Quality standards.
- C. Samples: Plastic laminates in each type, color, pattern, and surface finish required in manufacturer's standard size.
- D. Samples for Initial Selection: For plastic laminates.
- E. Samples for Verification: As follows:
 - 1. Plastic Laminates: For each type, color, pattern, and surface finish required, 8 by 10 inches (200 by 250 mm) in size.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For the following:
 - 1. Composite wood and agrifiber products.
 - 2. High-pressure decorative laminate.
 - 3. Chemical-resistant, high-pressure decorative laminate.
 - 4. Adhesives.

- B. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.
- B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- C. Keep surfaces of countertops covered with protective covering during handling and installation.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- D. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD COUNTERTOPS

- A. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS. PLAM-1
 - 1. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:
 - a. Formica Corporation;
 - b. Nevamar Decorative Surfaces;

- c. Wilsonart International;
- B. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. As selected by Architect from manufacturer's full range.
- C. Edge Treatment: As indicated on Drawings.
- D. Core Material: MDF.
- E. Core Material at Sinks: MDF made with exterior glue.
- F. Core Thickness: 3/4 inch (19 mm).
- G. Paper Backing: Provide paper backing on underside of countertop substrate.

2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.
 - 1. Wood Moisture Content: 5 to 10 percent.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products according to test method indicated by a qualified testing agency.
 - 1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
 - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 - 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 - 2. For items indicated to receive a stained or natural transparent finish, use organic resin chemical formulation.
 - 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 - 4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying

sticks or other causes, marring, and other defects affecting appearance of exposed treated woodwork.

- C. Fire-Retardant MDF: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less according to ASTM E84.

2.4 ACCESSORIES

- A. Wire-Management Grommets: Circular, molded-plastic grommets and matching plastic caps with slot for wire passage.
 - 1. Outside Diameter: 2 inches (51 mm).

2.5 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch (25 mm) over base cabinets. Ease edges to radius indicated for the following:
 - 1. Solid-Wood (Lumber) Members: 1/16 inch (1.5 mm) unless otherwise indicated.
- C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times countertop fabrication will be complete.
 - 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended, and check measurements of assemblies against field measurements before disassembling for shipment.
- D. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of cutouts by saturating with varnish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.

- B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.2 INSTALLATION

- A. Grade: Install countertops to comply with same grade as item to be installed.
- B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
 - 1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 2. Seal edges of cutouts by saturating with varnish.
- C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
 - 1. Secure field joints in countertops with concealed clamping devices located within 6 inches (150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
- D. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical-treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- F. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches (3-mm-in-2400-mm) variation from a straight, level plane.
 - 2. Secure backsplashes to tops with concealed metal brackets at 16 inches (400 mm) o.c. and to walls with adhesive.
 - 3. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects. Where not possible to repair, replace countertops. Adjust joinery for uniform appearance.
- B. Clean countertops on exposed and semiexposed surfaces.

- C. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches (1220 mm) o.c. Remove protection at Substantial Completion.

END OF SECTION 12 36 23.13

SECTION 12 36 61.13 - CULTURED MARBLE COUNTERTOPS

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. Cultured marble countertops.
 - 2. Integral sinks.
 - 3. Integral backsplashes.
 - 4. Integral end splashes.
 - 5. Loose end splashes.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, integral sinks, and methods of joining.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches (150 mm) square.
 - 2. One full-size cultured marble countertop, with front edge and backsplash, 8 by 10 inches (200 by 250 mm), of construction and in configuration specified.

1.4 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Comar
- B. Marcraft
- C. Equal product approved by Architect in an addendum.

2.2 CULTURED MARBLE COUNTERTOPS

- A. Cultured Marble: Gel-coated solid fabrication of filled plastic resin complying with CSA B45.5/IAPMO Z124.
 - 1. Colors and Patterns: As selected by Architect from manufacturer's full range.
- B. Configuration: One-piece units with integral sink bowls and backsplashes unless otherwise indicated, not less than 1/2 inch (12.7 mm) thick.
 - 1. Front: Straight, slightly eased at top.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by cultured marble manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m).
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer.
 - 1. Install end splashes to comply with manufacturer's written instructions.
- C. Install aprons to backing and countertops with adhesive. Fasten by screwing through backing. Pre-drill holes for screws as recommended by manufacturer.
- D. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants." Remove temporary shims before applying sealant.

END OF SECTION 12 36 61.13

SECTION 12 36 61.16 - SOLID SURFACING COUNTERTOPS

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. Solid surface material countertops.
 - 2. Solid surface material backsplashes.
 - 3. Solid surface material end splashes.
 - 4. Solid surface material apron fronts.
 - 5. Solid surface material sinks.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials and sinks.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches (150 mm) square.
 - 2. Wood trim, 8 inches (200 mm) long.
 - 3. One full-size solid surface material countertop, with front edge and backsplash, 8 by 10 inches (200 by 250 mm), of construction and in configuration specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - 1. Build mockup of typical countertop as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
 - 1. Manufacturers:
 - a. Avonite
 - b. DuPont
 - c. Formica
 - d. Equal product approved by Architect in an addendum.
 - 2. Type: Provide Standard type unless Special Purpose type is indicated.
 - 3. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
 - 4. Colors and Patterns: As selected by Architect from manufacturer's full range.
- B. Solid Wood Edges and Trim if shown: Clear white oak lumber, free of defects, selected for compatible grain and color, and kiln dried to 7 percent moisture content.
- C. Particleboard: ANSI A208.1, Grade M-2.
- D. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Premium.
- B. Configuration:
 - 1. Front: Straight, slightly eased at top.
- C. Countertops: 3/4-inch- (19-mm-) thick, solid surface material.
- D. Backsplashes: 3/4-inch- (19-mm-) thick, solid surface material.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
 - 2. Install integral sink bowls in countertops in the shop.
- F. Joints: Fabricate countertops without joints.
- G. Joints: Fabricate countertops in sections for joining in field, with joints at locations indicated.
- H. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch (5 mm) into fixture opening.
 - b. Provide vertical edges, rounded to 3/8-inch (10-mm) radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch (5 mm) into fixture opening.
 - c. Provide 3/4-inch (20-mm) full bullnose edges projecting 3/8 inch (10 mm) into fixture opening.
 - 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
 - 4. Counter-Mounted Cooktops: Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m), 1/4 inch (6 mm) maximum. Do not exceed 1/64-inch (0.4-mm) difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints where indicated. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
 - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- I. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

END OF SECTION 12 36 61.16

SECTION 12 36 61.19 - QUARTZ AGGLOMERATE COUNTERTOPS

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. Quartz agglomerate countertops.
2. Quartz agglomerate backsplashes.
3. Quartz agglomerate end splashes.
4. Quartz agglomerate apron fronts.

B. Related Requirements:

1. Section 22 41 00 "Residential Plumbing Fixtures" for sinks and plumbing fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Sustainable Design Submittals:

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

D. Samples for Initial Selection: For each type of material exposed to view.

E. Samples for Verification: For the following products:

1. Countertop material, 6 inches (150 mm) square.
2. Wood trim, 8 inches (200 mm) long.
3. One full-size quartz agglomerate countertop, with front edge and backsplash, 8 by 10 inches (200 by 250 mm), of construction and in configuration specified.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For quartz agglomerate countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - 1. Build mockup of typical countertop as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

- A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with ICPA SS-1, except for composition.
 - 1. Manufacturers:
 - a. Cambria
 - b. DuPont
 - c. Technistone
 - d. Equal product approved by Architect in an addendum
 - 2. Colors and Patterns: As selected by Architect from manufacturer's full range.
- B. Solid Wood Edges and Trim if shown: Clear white oak lumber, free of defects, selected for compatible grain and color, and kiln dried to 7 percent moisture content.
- C. Particleboard: ANSI A208.1, Grade M-2.

- D. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Premium.
- B. Configuration:
 - 1. Front: Straight, slightly eased at top.
- C. Countertops: 3/4-inch- (19-mm-) thick, quartz agglomerate.
- D. Backsplashes: 3/4-inch- (19-mm-) thick, quartz agglomerate.
- E. Fabricate tops with shop-applied edges[and backsplashes] unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
- F. Joints: Fabricate countertops without joints.
- G. Joints: Fabricate countertops in sections for joining in field, with joints at locations indicated.
- H. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch (5 mm) into fixture opening.
 - b. Provide vertical edges, rounded to 3/8-inch (10-mm) radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch (5 mm) into fixture opening.
 - c. Provide 3/4-inch (20-mm) full bullnose edges projecting 3/8 inch (10 mm) into fixture opening.
 - 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
 - 4. Counter-Mounted Cooktops: Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by quartz agglomerate manufacturer.

- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m), 1/4 inch (6 mm) maximum. Do not exceed 1/64-inch (0.4-mm) difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints where indicated. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
 - I. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

END OF SECTION 12 36 61.19

SECTION 12 48 16 - ENTRANCE FLOOR GRILLES

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. Recessed floor grilles and frames.

1.3 COORDINATION

- A. Coordinate size and location of recesses in concrete to receive floor grilles and frames.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for entrance floor grilles and frames.
- B. Shop Drawings:
 - 1. Items penetrating floor grilles and frames, including door control devices.
 - 2. Divisions between grille sections.
 - 3. Perimeter floor moldings.
- C. Samples: For the following products, in manufacturer's standard sizes:
 - 1. Floor Grille: Assembled section of floor grille.
 - 2. Frame Members: Sample of each type and color.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For floor grilles and frames to include in maintenance manuals.

1.6 FIELD CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Babcock-Davis
- B. Balco
- C. J L Industries
- D. Nystrom

2.2 ENTRANCE FLOOR GRILLES, GENERAL

- A. Structural Performance: Provide floor grilles and frames capable of withstanding the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform floor load of 300 lbf/sq. ft. (14.36 kN/sq. m).
 - 2. Wheel load of 350 lb (159 kg) per wheel.
- B. Accessibility Standard: Comply with applicable provisions in the DOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.3 FLOOR GRILLES

- A. General: Provide manufacturer's standard floor-grille assemblies consisting of treads of type and profile indicated, interlocked or joined together by cross members, and with support legs (if any) and other components needed to produce a complete installation.
- B. Aluminum Floor Grilles: Provide manufacturer's standard floor grilles with extruded members, top-surfaced tread rails, and as follows:
 - 1. Tread Rails: Extruded aluminum tread rails, unless otherwise shown.
 - a. Aluminum Color: As selected by Architect from full range of industry colors and color densities.
 - 2. Tread Rail Spacing: 1-1/2 inches (38 mm) o.c. with 1/8- to 3/16-inch- (3.2- to 4.8-mm-) wide openings between treads.
 - 3. Top Surface: Serrated aluminum.
 - a. Top Surface Color: As selected by Architect from manufacturer's full range of industry colors.
 - 4. Grille Size: As indicated.

2.4 FRAMES

- A. Provide manufacturer's standard frames of size and style for grille type, for permanent recessed installation in subfloor, complete with installation anchorages and accessories. Unless otherwise indicated, fabricate frame of same material and finish as grilles.

2.5 SUPPORT SYSTEM

- A. Level Bed Applications: Provide manufacturer's standard, vinyl cushion support system.
- B. Drainage Pit Applications: Provide manufacturer's special deep-pit frame and support extrusion system with intermediate support beams, sized and spaced as recommended by manufacturer for indicated spans and equipped with vinyl support cushions.

2.6 MATERIALS

- A. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15.
- B. Extruded Aluminum: ASTM B221 (ASTM B221M), Alloy 6061-T6 or Alloy 6063-T5, T6, or T52 as standard with manufacturer.

2.7 FABRICATION

- A. Shop fabricate floor grilles to greatest extent possible in sizes as indicated. Unless otherwise indicated, provide each grille as a single unit; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in grilles are necessary, space symmetrically and away from normal traffic lanes.
- B. Fabricate frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.
- C. Coat surface of aluminum in contact with cementitious materials with manufacturer's standard protective coating.

2.8 ALUMINUM FINISHES

- A. Mill finish.

2.9 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Directional Satin Finish: ASTM A480/A480M No. 4.
- C. Mill finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and floor conditions for compliance with requirements for location, size, minimum recess depth, and other conditions affecting installation of floor grilles and frames.
- B. Examine roughing-in for drainage piping systems to verify actual locations of piping connections before floor grille and frame and drain pan installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install recessed floor grilles and frames to comply with manufacturer's written instructions at locations indicated and with top of floor grilles and frames in relationship to one another and to adjoining finished flooring as recommended by manufacturer. Set floor-grille tops at height for most effective cleaning action. Coordinate top of floor-grille surfaces with doors that swing across grilles to provide clearance under door.

3.3 PROTECTION

- A. After completing frame installations, provide temporary filler of plywood or fiberboard in floor-grille recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 12 48 16

SECTION 12 9000 – SITE FURNISHINGS

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. Benches
 - 2. Chairs
 - 3. Tables
 - 4. Trash Receptacles
 - 5. Planters
 - 6. Bicycle Racks
 - 7. Fire Bowls

1.3 DEFINITIONS

- A. The Illinois Department of Transportation Standard Specifications for Road and Bridge Construction, current edition and all subsequent amendments, referred herein as IDOT Standard Specifications.

1.4 ACTION SUBMITTALS

- A. Product Data
 - 1. Cut sheets for all site furnishings
 - 2. Manufacturers' product warranties

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years' experience construction of similar structures. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor is responsible to protect and avoid all existing above ground and underground utilities during construction operations. Repair of any utilities damaged by construction shall be the responsibility of the Contractor.
- C. Contractor is responsible to protect all existing conditions including structures, pavement and plant material from damage during project construction. Any damages occurring shall be the responsibility of the Contractor to replace, repair or compensate Owner for damages to the satisfaction of the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. All products to be carefully handled and stored as to avoid damage.

PART 2 – PRODUCTS

2.1 PRODUCTS AND MATERIALS (products used at UIS Student Union)

A. Benches

1. Aluminum bench with slatted seats and back.
2. Approximate dimensions 75½" x 26¾" x 33¼"
3. Manufactured by one of the following
 - a. Winchester Series manufactured by Urbanscape, 505 W. Main Street, Silver Lake, IN 46982, 866-903-3714, www.wabashvalley.com. Color: Stainless frame with espresso faux-wood slats.
 - b. Cunningham Bench model # CNB-6-HS-P manufactured by Thomas-Steele, 1080 Uniek Drive, Waunakee, WI 53597, 800-241-2505, www.thomas-steele.com Color: Bronze.
 - c. Framers Modern Collection, model # FMBF-324, 6' length, manufactured by Victor Stanley, P.O. Drawer 330, Dunkirk, MD 20754, 800-368-2573, www.victorstanley.com Color: Bronze
 - d. Equal as approved by UIS Facilities

B. Chairs

1. Aluminum armchair with slatted seats and back.
2. Approximate dimensions 22" x 22" x 29¾"
3. Manufactured by one of the following
 - a. Winchester Series manufactured by Urbanscape, 505 W. Main Street, Silver Lake, IN 46982, 866-903-3714, www.wabashvalley.com. Color: Stainless frame with espresso faux-wood slats.
 - b. Cunningham Chair model CNB-2-HS-P manufactured by Thomas-Steele, 1080 Uniek Drive, Waunakee, WI 53597, 800-241-2505, www.thomas-steele.com Color: Bronze.
 - c. Framers Modern Collection, model # FMBF-324, custom 2' length, manufactured by Victor Stanley, P.O. Drawer 330, Dunkirk, MD 20754, 800-368-2573, www.victorstanley.com Color: Bronze
 - d. Equal as approved by UIS Facilities

C. Tables

1. Aluminum table with slatted surface and four legs.
2. Approximate dimensions: 48" diameter x 30-3/8" height
3. Manufactured by one of the following
 - a. Yorktown Series manufactured by Urbanscape, 505 W. Main Street, Silver Lake, IN 46982, 866-903-3714, www.wabashvalley.com. Color: Espresso faux-wood.
 - b. Custom table manufactured by Keystone Ridge Designs, 670 Mercer Road, Butler, PA 16001-1840, 1-800-284-8208, www.krdusa.com Finish: Dark Bronze.
 - c. Custom table manufactured by Thomas-Steele, 1080 Uniek Drive, Waunakee, WI 53597, 800-241-2505, www.thomas-steele.com Color: Dark Bronze
 - d. Equal as approved by UIS Facilities

D. Trash Receptacles

1. Concrete receptacle with standard sandblast finish manufactured by one of the following:

- a. Model LR1070 as manufactured by Doty & Sons Concrete Products Inc., 1275 East State Street, Sycamore, IL 60178, 1-800-233-3907, www.dotyconcrete.com
 - 1) Concrete receptacle with a 31 gallon liner, 675 lbs.
 - 2) 26" diameter x 43½" height with two (2) litter openings
 - 3) SB6 Standard Sandblast finish
- b. Model TCRCA-SO as manufactured by Peterson Manufacturing Company Inc., PO Box 664, Denison, IA 51442, 1-800-832-7383, www.petersenmfg.com
 - 1) Concrete receptacle with liner, 1,000 lbs.
 - 2) 30" diameter x 42" height with one (1) litter opening
 - 3) Light Sandblasted finish, Dove Gray color
- c. Model TF1150 as manufactured by Wausau Tile Inc., 9001 Bus. Hwy 51, Rothschild, WI 54474, 715-359-3121, www.wausautile.com
 - 1) Concrete receptacle with 41 gallon liner, 610 lbs.
 - 2) 26" diameter x 47" height with two (2) litter openings
 - 3) Plastic lid with standard cable anchoring
 - 4) Weatherstone finish, Gray color
- d. Equal as approved by UIS Facilities

E. Planters

1. Reinforced concrete or cast stone prairie style planter with standard finish manufactured by one of the following:
 - a. Model #SL4031 as manufactured by Wausau Tile Inc., 9001 Bus. Hwy 51, Rothschild, WI 54474, 715-359-3121, www.wausautile.com
 - 1) Reinforced concrete, 72" diameter x 28½" height with 39" cruciform base, 2,300 pounds
 - 2) Drainage hole at bottom of planter
 - 3) Polished Buff color
 - b. Model #LS9091 – Carbondale 60 Plain as manufactured by Longshadow Planters, 83 Longshadow Lane, Pomona, IL 62975, 618-893-4831, www.longshadow.com
 - 1) Cast stone, 60" diameter x 26" height with 34" cruciform base, 1,797 pounds
 - 2) Drainage hole at bottom of planter
 - 3) Natural color
 - c. Manufactured by Doty and Sons Concrete Products Inc., 1275 East State Street, Sycamore, IL 60178, 1-800-233-3907, www.dotyconcrete.com
 - 1) Custom reinforced concrete planter, 72" diameter to match item "a" above
 - 2) Drainage hole at bottom of planter
 - 3) SB6 Standard Sandblast finish
 - d. Equal as approved by UIS Facilities

2. Planter fill materials
 - a. Pea Gravel: ½" to 1" diameter, light to medium brown color.
 - b. Filter Fabric: 6 oz. weight non-woven fabric meeting standards of Section 282 – Filter Fabric, IDOT Standard Specifications.
 - c. Potting Soil: Commercial potting soil mix comprised of equal parts of peat moss, rotted cow or horse manure and vermiculite and enhanced with fertilizer, forming a good growth medium for flowers.

F. Bicycle Racks

1. 2-3/8" outside diameter steel frame, 5 loop – 7 bike capacity rack manufactured by one of the following:
 - a. Model #H36-7-IG, Heavy Duty Challenger Bike Rack as manufactured by Madrax 1080 Uniek Drive, Waunakee, WI 53597, 1-800-448-7931, www.madrax.com
 - In ground mount
 - 36" height x 64" length
 - Powder Coat finish, Black color
 - b. Model #1602-07, Roller Coaster Bike Rack as manufactured by Patterson-Williams Athletic Mfg. Co., 140 N Gilbert Rd, Mesa, AZ 85203, 480-962-5289, www.pwathletic.com
 - In ground mount
 - 36" height x 64" length
 - Powder Coat finish, Black color
 - c. Model #BRCS-105, Cycle Sentry Collection as manufactured by Victor Stanley, P.O. Drawer 330, Dunkirk, MD 20754, 1-800-368-2573, www.victorstanelly.com
 - In ground mount
 - Powder Coat finish, Black color
 - d. Equal as approved by UIS Facilities

G. Fire Bowls

1. Reinforced Concrete Fire Bowl manufactured from high strength concrete specifically for use with natural gas flame. Creamy Buff color.
2. Dimensions: 60" diameter x 18" high with 12" oversized lip
3. Manual key valve for emergency shut off located on exterior of fire bowl.
4. Fire Bowl Accessories
 - a. 24 volt electronic cross fire pit system with remote control igniter switch.
 - b. Fire bowl pan, sized to fit concrete bowl and support burner and fire stones.
 - c. Cross fire 22-3/16" x 21-11/16" bronze burner with 45 degree natural gas jets as recommended by fire bowl manufacturer.
 - d. Gas flex line for system connections.
 - e. Fire stones, natural tan/gray color.
5. Manufactured or supplied by one of the following
 - a. Warming Trends LLC, 1695 West Sheri Lane Littleton, CO 80120 303-346-

- b. 2224 www.warming-trends.com Model: Custom Simplicity Fire Bowl 1
Concrete Creations, Los Angeles, CA, 888-299-8273,
www.concretecreationsla.com
- c. Equal as approved by UIS Facilities

2.2 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle to prevent damage to the products and materials.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Benches

1. Position benches on pavement where shown on plans.
2. Verify position with Owner's Representative.

B. Tables and Chairs

1. Position table and chair units on pavement where shown on plans.
2. Verify position with Owner's Representative.

C. Trash Receptacles

1. Position trash receptacle on pavement where shown on plans.
2. Verify position with Owner's Representative.

D. Planters

1. Position planter on pavement where shown on plans.
2. Verify position with Owner's Representative.
3. Fill planters.
 - a. Fill bottom layer with pea gravel to the thickness shown on plan.
 - b. Cover pea gravel with filter fabric.
 - c. Place potting soil over filter fabric and firmly tamp to the level shown on plans.
 - d. Planting will be done by others.

E. Bicycle Racks

1. Excavate holes for footings according to plans and manufacturer's recommendations.
2. Set steel pipes of bicycle rack in excavated holes straight and plumb at final elevation. Heights at each end to be equal above finished surface.
3. Insert 3/8" anchor rod through hole at base of pipe.
4. Pour concrete footings. Top of footing elevation flush with brick paver base course as shown on plans.

F. Fire Bowls

1. Install gas lines, electrical supply, master control switch, emergency switch, and timer according to project plans and all applicable codes. See MEP plans and specifications for all supply lines, switches, and connections.
2. Pour Concrete Base according to 13 1315 – Special Concrete.

3. Place fire bowl on concrete base.
4. Connect gas line according to manufacturer's instructions.
5. Connect electrical supply to control module.
6. Install fire pan with control module, crossfire burner, and igniter according to manufacturer's instructions.
7. Fill pan with fire stones flush with the top surface of the concrete fire bowl. Stones to completely cover burner. Install stones according to manufacturer's instructions to ensure igniter can function properly.

3.2 REPAIR

- A. Repair any scuffing or other surface marring to the satisfaction of the Owner's Representative.

END OF SECTION 12 9000

SECTION 14 21 00 - ELECTRIC TRACTION ELEVATORS

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 electric traction machine room-less passenger elevators.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
 - 2. Division 4 Section "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
 - 3. Division 5 Section "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Divider beams.
 - c. Hoist beams.
 - d. Structural-steel shapes for subsills.
 - e. Pit ladders.
 - f. Cants in hoistways made from steel sheet.
 - 4. Division 9 Section "Tiling" for finish flooring in elevator cars.
 - 5. Division 26 Sections for electrical service for elevators to and including fused disconnect switches at machine room door.
 - 6. Division 26 Section "Fire Detection Voice Alarm System" for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.
 - 7. Division 27 Section "Communications Horizontal Cabling" for telephone service for elevators.

1.3 DEFINITIONS

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.
- B. Service Elevator: A passenger elevator that is also used to carry freight.

1.4 ACTION SUBMITTALS

- A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include Product Data for car enclosures, hoistway entrances, and operation, control, and signal systems.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure, relationships with other construction, and locations of equipment.
 - 2. Include large-scale layout of car-control station and standby power operation control panel.
 - 3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
- C. Samples for Initial Selection: For finishes involving color selection.
- D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch- (75-mm-) square Samples of sheet materials; and 4-inch (100-mm) lengths of running trim members.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Data: Certificates, for elevator equipment, 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.
- C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as indicated on Drawings, and electrical service including standby power generator if required, as shown and specified, are adequate for elevator system being provided.
- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
 - 1. Submit manufacturer's or Installer's standard operation and maintenance manual, according to ASME A17.1/CSA B44, including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.

- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
- D. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner with terms, conditions, and obligations as set forth in, and in same form as, a "Draft of Elevator Maintenance Agreement," starting on date initial maintenance service is concluded.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

- A. Coordinate installation of inserts, sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, inserts, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Coordinate locations and dimensions of work specified in other Sections that relates to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
 - 2. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELEVATOR MANUFACTURERS

1. Otis Elevator Co.; Gen2.
2. Schindler; 3300 MRL and 5500 MRL.
3. Equal approved by Architect in an addendum.

A. Source Limitations: Obtain elevators from single manufacturer.

1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and shall comply with elevator seismic requirements in ASME A17.1/CSA B44.

1. Provide earthquake equipment required by ASME A17.1/CSA B44.
2. Provide seismic switch required by ASCE/SEI 7.

2.3 OPERATION SYSTEMS

A. General: Provide manufacturer's standard microprocessor operation system for each elevator as required to provide type of operation system indicated.

B. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators and elevator groups where indicated:

1. Battery-Powered Lowering: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered one at a time to the next floor below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
2. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.
3. Nuisance Call Cancel: When car calls exceed a preset number while the car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight can be adjusted.
4. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car will respond only to car calls, not to hall calls.

C. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.

1. Keyswitch Operation: Push buttons to the Attic level are activated and deactivated by security keyswitches at car control stations. Key is removable only in deactivated

position. Keyswitch shall have Best core.

2.2 DOOR REOPENING DEVICES

- A. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.3 FINISH MATERIALS

- A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
- D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- E. Stainless-Steel Bars: ASTM A 276, Type 304.
- F. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
- G. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.
- H. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.
- I. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications.

2.4 CAR ENCLOSURES

- A. General: Provide enameled-steel car enclosures to receive removable wall panels, with removable car roof, access doors, power door operators, and ventilation.
 - 1. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.
 - 2. Provide finished car including materials and finishes specified below.
- B. Materials and Finishes: Provide manufacturer's standards, but not less than the following:
 - 1. Subfloor: Underlayment grade, exterior plywood, 5/8-inch (16-mm) nominal thickness.
 - 2. Floor Finish: Specified in Division 09 Section "Ceramic Tiling".
 - 3. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to 1/2-inch (13-mm) fire-retardant-treated particleboard with plastic-laminate panel backing and manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 or less, when tested according to ASTM E 84. Plastic-laminate color, texture, and

- pattern as selected by Architect from plastic-laminate manufacturer's full range.
4. Fabricate car with recesses and cutouts for signal equipment.
 5. Fabricate car door frame integrally with front wall of car.
 6. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
 7. Sight Guards: Provide sight guards on car doors.
 8. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.
 9. Metal Ceiling: Flush panels, with four low-voltage downlights in each panel. Align ceiling panel joints with joints between wall panels.
 10. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

2.5 HOISTWAY ENTRANCES

- A. General: Provide manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Provide frame size and profile to coordinate with hoistway wall construction.
 1. Where gypsum board wall construction is indicated, provide self-supporting frames with reinforced head sections.
- B. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:
 1. Stainless-Steel Frames: Formed from stainless-steel sheet.
 2. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
 3. Sight Guards: Provide sight guards on doors matching door edges.
 4. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.
 5. Non-shrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

2.6 SIGNAL EQUIPMENT

- A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life incandescent lamps and acrylic or other permanent, non-yellowing translucent plastic diffusers or LEDs.
- B. Car Control Stations: Provide manufacturer's standard recessed car control stations. Mount in return panel adjacent to car door, unless otherwise indicated.
 1. Mark buttons and switches with standard identification for required use or function that complies with ASME A17.1. Use both tactile symbols and Braille.
 2. Provide "No Smoking" sign matching car control station, either integral with car control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with

identification, instructions for use, and battery backup power supply.

- D. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section "Fire Detection and Alarm."
- E. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car control station. Also provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served.
 - 1. Include travel direction arrows if not provided in car control station.
- F. Hall Push-Button Stations: Provide one hall push-button station at each landing.
 - 1. Provide manufacturer's standard wall-mounted units.
 - 2. Provide units with flat faceplate for mounting with body of unit recessed in wall.
 - 3. Equip units with buttons for calling elevator and for indicating desired direction of travel.
 - 4. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Division 28 Section "Fire Detection and Alarm."
- G. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:
 - 1. Units mounted in both jambs of entrance frame for each elevator.
- H. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
 - 1. At manufacturer's option, audible signals may be placed on each car.
- I. Corridor Call Station Pictograph Signs: Provide signs matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station, unless otherwise indicated.

2.7 TYPICAL ELEVATORS (VERIFY)

A. Elevator Description:

- 1. Type: Electric traction low rise machine room-less elevator.
- 2. Rated Load: 2500 lb (1135 kg).
- 3. Rated Speed: 150 fpm (0.8 m/s).
- 4. Operation System: Single elevator.
- 5. Auxiliary Operations:
 - a. Standby power operation.
 - b. Automatic dispatching of loaded car.
 - c. Nuisance call cancel.
- 6. Car Enclosures:
 - a. Inside Width: 80 inches (2032 mm) from side wall to side wall.
 - b. Inside Depth: 51 inches (1295 mm) from back wall to front wall (return panels).

- c. Inside Height: 93 inches (2362 mm) to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
 - e. Side Wall Panels: Manufacturer's standard vertical plastic laminate panels
 - f. Rear Wall Panels: Same construction as side walls.
 - g. Door Faces (Interior): Satin stainless steel, No. 4 finish.
 - h. Door Sills: Aluminum, mill finish.
 - i. Ceiling: Satin stainless steel, No. 4 finish with manufacturer's standard disc lights.
 - j. Handrails: 1/2 by 2 inches (13 by 50 mm) rectangular satin stainless steel, No. 4 finish, at sides and rear of car.
 - k. Floor recessed and prepared to receive ceramic tile (specified in Section 093013 "Ceramic Tiling").
7. Hoistway Entrances:
- a. Width: 42 inches (1067 mm).
 - b. Height: 84 inches (2134 mm).
 - c. Type: Single-speed center opening.
 - d. Location: Front and rear.
 - e. Fire-Protection Rating: 1-1/2 hours with 30-minute temperature rise of 450 deg F (250 deg C).
8. Additional Requirements:
- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
 - b. Provide blanket hooks in all cars and one complete set of full-height protective blankets for one car.
 - c. Provide single Category 6 UTP cable to be included in the elevator traveler cable connecting the elevator control room and a two gang 3-1/2 inch deep backbox in the elevator cab ceiling.
9. Additional Requirements:
- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
 - b. Provide blanket hooks in all cars and one complete set of full-height protective blankets for one car.
 - c. Provide single Category 6 UTP cable to be included in the elevator traveler cable connecting the elevator control room and a two gang 3-1/2 inch deep backbox in the elevator cab ceiling.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions.
- B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
- C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
- E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- F. Leveling Tolerance: 1/8 inch (3 mm), up or down, regardless of load and travel direction.
- G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- H. Locate hall signal equipment for elevators as follows unless otherwise indicated:
 - 1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
 - 2. Place hall lanterns either above or beside each hoistway entrance.
 - 3. Mount hall lanterns at a minimum of 72 inches (1829 mm) above finished floor.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
- B. Operating Test: Load each elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.
- C. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

- A. Temporary Use: Limit temporary use for construction purposes to one elevator. Comply with the following requirements for each elevator used for construction purposes:
1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 2. Provide strippable protective film on entrance and car doors and frames.
 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 5. Do not load elevators beyond their rated weight capacity.
 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
 7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
1. Perform maintenance during normal working hours.
 2. Perform emergency callback service during normal working hours with response time of two hours or less.
 3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of two hours or less.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
- B. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 21 00

SECTION 211000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART I - GENERAL

1.1 SUMMARY

- A. Inclusion of sprinkler and standpipe systems shall be as determined by NFPA National Fire Code pamphlet 101 and program statement. Provide equipment, material, devices, labor, and supervision necessary to fabricate and erect hydraulically designed Wet Pipe and Dry Pipe Fire Suppression Sprinkler Systems as required by the Drawings and this Section.

1.2 CODES AND REGULATIONS

- A. Sprinkler system design, equipment, materials, devices, and installation shall conform to the following:
 - 1. NFPA National Fire Code pamphlets 13 (or 13R), 14, 101, and other applicable pamphlets.
 - 2. International Fire Code (NFPA National Fire Code pamphlet 101 shall take precedence where conflicts arise)
 - 3. Underwriters Laboratory
 - 4. Fire Investigation Act. Part 41, Illinois Administrative Code Section 425, Section 25/6

1.3 WIRING

- A. The Division 26 Contractor shall furnish wiring for signal and alarm devices furnished by sprinkler contractor.

1.4 SPRINKLER DESIGN

- A. Fire Hydrant Flow Test: Sprinkler system hydraulic calculations shall be based on a recent (within five calendar years or since the last major modification was made to the surrounding distribution system) fire hydrant flow test as performed by the Water Company. Hydrants used should be immediately adjacent to water service connection building.
- B. Fire Service Line: The fire service line to the building is preferred to also provide domestic water service. Therefore, the fire protection contractor will start work at the backflow preventer.

1.5 SUBMITTALS

- A. Product Data: Product Data: Submit manufacturer's technical product data and installation instructions for all fire protection materials and products.
- B. Shop Drawings: Contractor shall submit scaled, dimensioned installation drawings and supporting hydraulic calculations. Contractor shall provide drawings and calculations that are prepared and stamped by a Registered Engineer or NICET Level III or Level IV Designer.
- C. Contractor's Material & Test Certificate: Submit completed Contractor's Material & Test Certificate for each system.
- D. At project closeout, submit record drawings of installed fire protection piping and products.
- E. Submit operating and maintenance data and parts lists for fire protection materials and products. Include this data, product data, shop drawings, approved drawings, approved calculations, certificate of installation, and record drawings in maintenance manual.

PART 2 - PRODUCTS

2.1 FIRE PUMPS

- A. Fire pumps shall be electric driven horizontal splitcase centrifugal type as manufactured by Aurora, Patterson, Peerless, and Xylem/ITT-AC.
- B. Fire Pump Controllers: Masters, Firetrol, and Cutler-Hammer/Eaton
- C. Motors: Refer to Division 26

2.2 FITTINGS

- A. Couplings: Grooved couplings shall be prelubricated type only. Any field lubrication is prohibited.
- B. Cast-Iron Threaded Flanges: ASME B16.1, Class 125, raised ground face, bolt holes spot faced.
- C. Cast-Iron Threaded Fittings: ASME B16.4, Class 125, and standard pattern, with threads according to ASME B1.20.1.
- D. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, and standard pattern, with threads according to ASME B1.20.1.
- E. Grooved-End Fittings for Ductile-Iron Pipe: ASTM A 536 ductile-iron or ASTM A 47 malleable-iron, AWWA pipe-size, designed to accept AWWA C606 grooved couplings. Include cement lining or Food and Drug Administration (FDA)-approved interior coating.
- F. Steel Fittings: ASTM A234, seamless or welded; ASME B16.9, buttwelding; or ASME B16.11, socket-welding type for welded joints.
- G. Steel Flanges and Flanged Fittings: ASME B16.5.
- H. Grooved-End Fittings for Steel Pipe: UL-listed and FM-approved, ASTM A 536, Grade 65-45-12 ductile iron or ASTM A 47 Grade 32510 malleable iron, with grooves or shoulders designed to accept grooved couplings.
- I. "Full-body style" mechanical tees are acceptable. "U-bolt style" mechanical tees are not allowed.

2.3 PIPE

- A. Use pipe, fittings, and joining methods according to the following applications. Piping may be joined with flanges instead of indicated joints. Use grooved end fittings with grooved couplings that are made by the same manufacturer and that comply with listing when used together for grooved-coupling joints.
- B. All sprinkler piping in fire pump room or where the fire service enters the building shall be painted to prevent external corrosion.
- C. Pipe between Backflow Preventer and Pump: Use galvanized steel for piping between the backflow preventer and pump.
- D. Drains and Pipe between Fire Department Connections and Check Valves: Use Galvanized steel pipe instead as specified below for dry pipe systems. Do not use welded joints.
- E. Sizes 2" and Smaller for Wet Pipe Systems: ASTM A 53 or A 135 Schedule 40 steel pipe with rolled-groove or cut-groove ends, grooved-end steel pipe fittings, and grooved-coupling joints. Threaded fittings and joints are also acceptable.
- F. Sizes 2" and Smaller for Dry Pipe Systems: ASTM A 53 or A 135 Schedule 40 galvanized steel pipe with cut-groove ends, grooved-end steel pipe fittings, and grooved-coupling joints. Threaded fittings and joints are also acceptable.
- G. Sizes 2 ½ and larger for Wet Pipe Systems: ASTM A 135 or A 795, Schedule 10 (minimum) steel pipe with rolled groove ends, grooved-end steel pipe fittings, and grooved-coupling joints.
- H. Sizes 2 ½ " and larger for Dry Pipe Systems: ASTM A 135 or A 795, Schedule 10 (minimum) galvanized steel pipe with grooved-end steel pipe fittings, and grooved-coupling joints.
- I. UL approved flexible stainless steel piping drops to sprinkler heads are allowed.

2.4 SPRINKLERS

- A. Components: O-rings shall not be used with any sprinkler.
- B. Response Rating: Automatic Sprinklers with quick-response element conforming to UL 199 for applications except residential. Replace existing adjacent sprinklers when they are not quick response.
- C. Sprinkler types and categories are as indicated and as required by application. Furnish automatic sprinklers with nominal 1/2-inch orifice and 1/2-inch NPT when available.
- D. Sprinkler types include:
 - 1. Coated or plated sprinklers
 - 2. Recessed sprinklers
 - 3. Sidewall sprinklers
 - 4. Upright sprinklers
 - 5. Concealed sprinklers
- E. Sprinkler Finishes: Painted, chrome, and bronze
- F. Sprinkler Escutcheons: Escutcheons for recessed-type sprinklers are specified with sprinklers.
- G. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.
- H. Sprinkler Cabinets: Finished steel cabinets and hinged cover, with space for minimum of 6 spare sprinklers plus sprinkler wrench, suitable for wall mounting. Include number of sprinklers required by NFPA 13 and 1 wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each style of sprinkler on project.
- I. Dry Sprinklers: Dry pendent and dry sidewall sprinklers shall be at least 24 inches long.

2.5 FLEXIBLE FIRE SPRINKLER CONNECTIONS

- A. Flexible Connection: Stainless steel hose, 175 psig max working pressure, fully welded non-mechanical fittings, stainless steel braid, maximum of 6' hose length, leak-tested with a minimum 7/8" internal corrugated hose diameter made of 304 stainless steel, end fittings made of carbon or stainless steel. Outlet of end fittings shall be 1/2" or 3/4" to match sprinkler connection. UL.
- B. Ceiling Bracket: G90 galvanized steel, direct attachment type, integrated snap-on clip ends, tamper resistance screws, removable attachment hub with set screw for attachment and adjustment of stainless steel hose.
- C. Acceptable Manufacturers: Flexhead Industries, Victaulic VicFlex, Sprinkflex, or approved equal.

2.6 SPECIALTY VALVES

- A. Ball Drip Valves: UL 1726 automatic drain valve, 3/4-inch size, spring loaded, ball check device with threaded ends.
- B. Backflow Preventer: Shall be Ames, Wilkins, Watts.
- C. Dry Pipe Valve: Dry Pipe Valves shall be UL-listed and FM-approved, with 175-psig working pressure. Include trim sets for bypass, drain, electric sprinkler alarm switch, air pressure monitoring switch, pressure gauges, precision retarding chamber, air line, and fill line attachment with strainer.
 - 1. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 - 2. Option: Grooved-end connections for use with grooved-end piping.
- D. Manual Air Vent: Require manual air vent at high point for each zone.

2.7 CONNECTIONS

- A. Flush, Wall-Type Fire Department Connections (*for buildings without basements*): UL 405, cast-brass body; National Standard Thread inlets according to NFPA 1963 and matching local fire department threads; and threaded NPS outlet. Include lugged cap, gasket, and chain; lugged swivel connection, extension pipe nipples, and clappers for each hose connection inlet; and a wall escutcheon plate with marking "AUTO SPKR".
 - 1. Finish: Polished brass
- B. Freestanding Fire Department Connections (*for buildings with basements*): Freestanding Fire Department Connections supplying standpipe systems shall be polished brass with double clappers, plugs and chains, polished brass sleeve to cover standpipe and escutcheon lettered "Standpipe." The 2-1/2 inch by 2-1/2 inch by 4 inch Fire Department Connection shall be located on the street side of the building not less than 18 inches or more than 48 inches above grade or adjoining ground.
- C. Standpipe Hose Connections: Each standpipe hose connection shall be 2 ½ inches and shall be approximately 4 feet, 6 inches above the floor.

2.8 ALARM DEVICES

- A. Waterflow Indicators: UL 346, electrical-supervision type, vane-type Waterflow detector, rated to 250 psig, and designed for horizontal or vertical installation. Include 2 SPDT (single-pole, double-throw) circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere, 125 volts AC and 0.25 ampere, 24 volts DC; complete with factory-set, field-adjustable retard element to prevent false signals, and tamper-proof cover that sends a signal when cover is removed.
- B. Supervisory Switches: UL 753 for valves, electrical-supervision type, SPDT (single-pole, double-throw), normally closed contacts, designed to signal controlled valve in other than full open position.
- C. Supervisory Pressure Switches (*Dry Systems*): UL 753, for low air alarm, air pressure switch with retard, electrical-supervision type, SPDT (single-pole, double-throw), normally closed contacts, designed to operate on rise or drop in air pressure.
- D. Acceptable Manufacturers: Potter, System Sensor, and Notifier.

2.9 PRESSURE GAUGES

- A. ANSI Grade AA (2A), ½% full scale accuracy
 - 1. 4½" diameter dial, with dial range of 0-250 psig.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. 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, or butterfly valves.
 - 2. Throttling Duty: Use globe, ball, or butterfly valves.

3.2 JOINT CONTRUCTION

- A. Grooved-End Pipe and Grooved-End Fitting Joints: Use groove-end fittings and grooved couplings that are made by the same manufacturer and that are listed for use together. Groove pipe and assemble joints with grooved coupling, pre-lubricated gasket, and bolts according to coupling and fitting manufacturer's written instructions. Field lubrication is prohibited. Fittings shall not be used to straighten a run of pipe and shall not exceed the amount of deflection recommended by the manufacturer.

3.3 SERVICE ENTRANCE PIPING

- A. Connect fire protection piping to building water service of size and in location indicated.
- B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories where indicated.

3.4 PIPING INSTALLATIONS

- A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved shop drawings for sprinkler piping require written approval from authority having jurisdiction. .
- B. Install flanges or flange adapters on valves, apparatus, and equipment have 2½-inch and larger connections.
- C. Main drains shall be located immediately after the backflow preventer and shall discharge to a location capable of accepting full flow under system pressure while allowing complete drainage to the outdoors (typically). Provisions shall be made to drain the main drain line at the conclusion of main drain tests. Floor drains can be used to provide drainage of the system but are not adequately sized for main drain tests.
- D. Sprinkler riser drains shall discharge into hub drains that are at least 4 inches in size.
- E. Gravity drain lines from fire pump shall be PVC. Pressurized drain lines shall be steel.
- F. Install Inspector's Test Connection, Drain, and relief valve at each riser, sized on the system riser. Route drains to outdoors or to a drain capable of accepting full flow under system water pressure such as a 4" hub drain. Custodial sinks are not considered proper drain receptors. Inspector's Test Connections use shall not require the use of ladders or temporary hoses.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install ball drip valves to drain piping between fire department connections and check valves, and where indicated. Drain outside building when elevations permit. Else, route drain line to floor drain.
- I. Install alarm devices in piping systems. Bells and water motor gongs on the exterior of the building are not desired. All flow switches, including those monitoring flow in standpipe systems, shall have a 45-second retard and shall have an Inspector's Test Connections for testing.
- J. Hangers and Supports: Comply with NFPA 13.
 - 1. Install hanger and support spacing and locations for steel piping joined with grooved mechanical couplings according to manufacturer's written instructions for rigid systems.
 - 2. Do not hang from joist bridging. Joist bridging is not considered structural.
- K. Install pressure gauges on riser. Include pressure gauges with connection not less than ¼" and with soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they will not be subject to freezing.
- L. Hold riser piping and components as close to wall as allowable. When in stairwells, install in the corner of the intermediate landings. Install riser components vertically, when possible, rather than

horizontally to minimize space requirements. Risers to second floor shall not pass through electrical rooms.

- M. For dry pipe systems, no portion of the sprinkler system shall be gridded, looped, or arranged in such a manner as to allow water to flow to any sprinkler from more than one direction.
- N. Air gaps (pockets) shall be avoided. Provide a manual air release through a quarter-turn ball valve at high points. Outlet shall be turned down to allow use of a bucket and it shall terminate in a $\frac{3}{4}$ " capped hose connection.

3.5 HYDRAULIC CALCULATIONS

- A. Size system piping such that total required system pressure at demand flow (including hose streams) is at least 5 psi less than the available pressure at demand flow.

3.6 VALVE INSTALLATIONS

- A. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and the authority having jurisdiction.
- B. Gate Valves: Install fire-protection service valves supervised-open, located to control sources of water supply. Where there is more than 1 control valve, provide permanently marked identification signs indicating portion of system controlled by each valve.
- C. Install tamper switches on valves controlling water supply to the sprinkler system.
- D. Install backflow preventers in potable water supply sources.
- E. Dry Pipe Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain line connection.
- F. Install permanent signs supported by chains identifying all drains, test connections, air supplies (for dry pipe systems), and water supply valves. Install placards indicating all hydraulic design criteria for each area and permanently attach placards to riser.

3.7 SPRINKLER APPLICATIONS

- A. Rooms without Ceilings: Upright sprinklers.
- B. Rooms with Ceilings: Recessed sprinklers.
- C. Beneath Overhead Doors: Sidewall sprinklers.
- D. Vestibules, stairwells, shipping, and other rooms with exterior doors: Dry pendent or dry sidewall sprinklers.
- E. Sprinkler Finishes: Use sprinklers with following finishes:
 - 1. Upright and Sidewall Sprinklers: Rough bronze.
 - 2. Recessed Sprinklers: White with white escutcheon.
- F. Sprinkler Temperature Ratings: Use sprinklers with the following temperature ratings in the applications listed unless noted otherwise on drawings:

1. Ordinary Temperature Classification (165° F): Top of elevator hoistways where ambient temperatures cannot exceed 100° F, bottom of elevator hoistways for hydraulic elevators, elevator machine rooms, public areas, offices, custodial rooms, mechanical equipment rooms, alteration room.
2. Intermediate Temperature Classification (212° F): Top of elevator hoistways where ambient temperatures can exceed 100° F, stock rooms, telephone/communication rooms.
3. Thermal Response: Quick response sprinklers shall be used for light hazard and ordinary hazard occupancies.

3.8 SPRINKLER INSTALLATIONS

- A. Install sprinklers in locations indicated. When sprinkler locations are not indicated in an area, locate sprinklers to meet this specification.
- B. Install sprinklers in suspended ceiling in center of acoustical panels and in center of half of acoustical panels, as shown on plans. The location of sprinklers may deviate up to 1 inch from the center, provided the deviation is continued for all sprinklers in the rows of both directions.
- C. Install sprinkler guards on sprinklers under overhead doors, in elevator hoistways, elevator machine rooms, electrical rooms, mechanical rooms, telephone/communication closets and on non-recessed heads within 90 inches of the floor.

3.9 ELEVATOR-RELATED REQUIREMENTS

- A. Machine Rooms: Sprinklers are required in all elevator machine rooms. NFPA 13, 5-13.6
- B. Hoistway Overhead No Sprinklers: No sprinklers shall be installed at the tops of elevator hoistways if a building is sprinkled "throughout" as per NFPA 5-13.6.3. *Exception. New construction shall never have sprinklers at the top of standard elevator hoistways.
- C. Sprinklers required in elevator Overhead in Existing buildings: Sprinklers are required in elevator overheads if the hoistway or existing elevator cab is not fire rated as per applicable codes.
- D. Hoistway Pit: Sprinklers are required in the pits of hydraulic elevators only.
- E. Shunt Trip: Per ASME A17.1 and IBC 3006.5, wherever elevator hoistway overheads or machine rooms are protected with automatic sprinklers, a means shall be provided to disconnect the main line power supply prior to the application of water. See *Section 26 80 00 - Elevator Electrical Requirements* for Shunt Trip Protection.

3.10 CONNECTIONS

- A. Connect to fire department connections and accessories.
- B. Connect water supplies to sprinkler systems. Include backflow preventers.
- C. Electrical Connections: By Division 26 Contractor.
- D. For Dry Pipe Systems: Connect air lines to air compressor controlled by an automatic air maintenance device. Flexible connections and hose are not allowed.

- E. Follow NFPA 24 testing requirements of below ground piping prior to connecting to the above ground pipes.

3.11 FIELD QUALITY CONTROL

- A. Perform field acceptance tests of each fire protection system with authority having jurisdiction present.
 - 1. Flush, test, and inspect sprinkler piping systems according to NFPA 13 Chapter "System Acceptance."
- B. Replace piping system components that do not pass test procedures specified, then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

3.12 CLEANING

- A. Clean dirt and debris from sprinklers. Replace sprinklers having paint other than factory finish with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.13 COMMISSIONING

- A. Starting Procedures: Follow manufacturer's written procedures. If manufacturer prescribes no procedures, proceed as follows:
 - 1. Verify that valves, trim, fittings, controls, and accessories have been installed correctly and operate correctly.
 - 2. Verify that specified tests of piping are complete.
 - 3. Check that damaged sprinklers and sprinklers with paint or coating not specified have been replaced with new, correct type of sprinklers.
 - 4. Check that sprinklers are correct type, have correct finish and temperature ratings, and have guards where required for applications.
 - 5. Check that potable water supplies have correct type of backflow preventer.
 - 6. Check that fire department connections have threads compatible with local fire department equipment and have correct pressure rating.
 - 7. Fill wet pipe sprinkler systems with water and bleed air through vents.
 - 8. Fill dry pipe sprinkler systems with air and drain water from low points.
 - 9. Energize circuits to electrical equipment and devices.
 - 10. Adjust operating controls and pressure settings.
- B. Coordinate with fire alarm system tests. Operate systems as required.

3.14 DEMONSTRATION

- A. Provide a demonstration of equipment, specialties, and accessories. Review operating and maintenance information.
- B. Schedule demonstration with at least 7 days advance notice.

END OF SECTION 211000

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 220716 - PLUMBING EQUIPMENT INSULATION

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Plumbing Equipment Insulation
- B. Plumbing Equipment Insulation Jackets
- C. Plumbing Equipment Insulation Finishes
- D. Plumbing Equipment Insulation Lagging

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type R: Rigid Fiberglass Board, 3.0 lb./cu. ft., ASTM C612 Type IA
- B. Type E: **EPDM** Cellular Flexible Elastomeric Foam Tube and Sheet, 300 deg. F maximum service temperature, ASTM C534 Grade 1
 - 1. **Not allowed: NBR/PVC blend**
 - 2. Approved Products
 - a. Aeroflex Aerocel
 - b. Armacell
 - (a) AP Armaflex FS
 - (b) UT Solaflex

2.2 JACKETS, FACTORY APPLIED

- A. ASJ: (All Service Jacket): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil vapor barrier backing
- B. FSK: Aluminum-foil vapor barrier, fiberglass-reinforced scrim with kraft-paper backing

2.3 FINISHES, FIELD APPLIED

- A. FM: Woven glass fabric with two coats of mastic approved for insulation type

2.4 TAPES, ADHESIVES, COATINGS, FASTENERS

- A. Provide in accordance with insulation manufacturer's specifications and requirements.
- B. Sheet metal screws installed outdoors shall be stainless steel with rubber washers. Galvanized screws shall not be used outdoors.

2.5 LAGGING, FIELD INSTALLED

- A. ALUM: Aluminum, .016" thick, stucco embossed finish.
 - 1. For protecting or securing insulation only, not for vapor barrier
- B. FMAS (Flexible Metallic Adhesive System): Self-adhesive embossed aluminum foil sheet, 6.0 mil minimum total thickness. Basis of design: VentureClad 1577CWE

2.6 REMOVABLE COVERS, CUSTOM MANUFACTURED

- A. Standard Applications, Less than 450 Degrees F.
 - 1. Jacket and liner: 17oz Silicone Impregnated Fiberglass Fabric

2. Insulation: 2" Type E Glass Mat
 - a. 1" allowed for constructability if approved by PSC
3. Fastenings:
 - a. 2" Nomex Velcro and/or Lace Hooks with Braided Kevlar Drawstrings
 - b. Stainless Steel Lace Hooks and Quilt Pins
4. Thread: Kevlar/Stainless Steel Thread
- B. Acoustical Applications, Less than 450 Degrees F.
 1. Additionally Provide 2 lb. Mass Loaded Vinyl
- C. Locations: Provide where shown on drawings or otherwise indicated in documents.

2.7 MATERIAL PROPERTIES

- A. Insulation material shall satisfy material property requirements of referenced ASTM standard. For convenient summary of referenced ASTM standards, see *Insulation Specification Materials Guide as presented by National Commercial and Industrial Insulation Association (NIA)*.
- B. All insulation materials, including jackets, tapes, adhesives and coatings, shall meet *ASTM E84 25/50 Flame Spread/Smoke Development* requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

1. General Requirements.
 1. Install insulation after equipment has been inspected and tested .
 2. Fit and secure insulation tightly to equipment.
 3. Insulate all equipment surfaces not factory insulated and with media design temperature above 105 deg. F, below 60 deg. F or below dew point of ambient air. When fluid is below dew point of ambient air, insulation shall have uninterrupted vapor barrier.
 4. Do not allow insulation to remain unsealed, vulnerable to entrance of moisture.
 5. Do not add insulation to factory-insulated surfaces.
 6. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.
 7. Provide field fabricated removable covers on equipment as required to provide ready access to components requiring periodic maintenance or repair.
 8. Provide custom manufactured removable covers as indicated in Application Schedule.
 9. Provide custom manufactured removable covers as indicated in Application Schedule.
 10. At a minimum, provide removable covers as identified in schedule.
 11. Provide sheet metal corner protection angles where insulation extends to floor or is similarly vulnerable to damage.
2. Specific Requirements for Insulation Type.
 1. Type R - Rigid Fiberglass Board.
 - a. Mechanically fasten to equipment.

2. Type E - Cellular Flexible Elastomeric Foam.
 - a. Form fit insulation tightly to equipment.
 - b. Fully adhere insulation to non-cylindrical equipment (e.g. pumps).
 - c. Generously adhere insulation to cylindrical equipment (e.g. water heaters, expansion tanks).
3. Additional Requirements for Outdoor Installations.
 1. Ensure insulation jacket is sealed waterproof, vapor tight.
 2. Provide tightly fitted metal lagging with overlapped sections properly oriented for prevailing weather.
 3. Mechanically attach lagging sections. Seal all seams and penetrations watertight.

3.2 APPLICATION SCHEDULE

SERVICE	INSULATION TYPE	JACKET TYPE	LAGGING	FINISH	MINIMUM THICKNESS
Domestic Water Meter	E	None	None	None	Same as adjacent piping
Domestic Booster Pump	E	None	None	None	1"
Domestic Water Heater - Insulate All Bare Surfaces - Provide field fabricated removable covers as required for periodic lime removal	R	FSK	None	FM	3" (or as clearance allows)
Domestic Hot Water Circulation Pump Body - Provide field fabricated removable cover	R	FSK	None	FM	1"
Domestic Hot Water Expansion Tank	R	FSK	None	FM	2"
Domestic Hot Water Storage Tank	R	FSK	None	FM	2"
Outdoor Cold Equipment	E	None	ALUM or FMAS	None	1 1/2" Default

Notes:

1. Manufacturer's thickness guide or calculation shall be used to determine required minimum insulation thickness for ambient temperature and humidity conditions. Applied insulation thickness shall meet or exceed this value. Thickness may exceed scheduled value.
2. Insulation thickness may be reduced only as required to accommodate tight clearances and other practical limitations.
3. For repairs, insulation thickness shall match existing.

END OF SECTION 220716

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 220719 - PLUMBING PIPING INSULATION

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Piping and Valve Insulation
- B. Insulation Jackets
- C. Insulation Lagging

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type F: Fiberglass, Semi-Rigid Premolded, ASTM C547 Type I
- B. Type M1: Mineral Wool, Semi-Rigid Premolded, 1,000 deg. F maximum service temperature, ASTM C547 Type IV
- C. Type E: **EPDM** Cellular Flexible Elastomeric Foam Tube and Sheet, 300 deg. F maximum service temperature, ASTM C534 Grade 1

- 1. **Not allowed: NBR/PVC blend**

- 2. Approved Products

- a. Aeroflex Aerocel
- b. Armacell
 - (a) AP Armaflex FS
 - (b) UT Solaflex

- D. Type P: Polyisocyanurate, Rigid Premolded, ASTM C591
- E. Type PH: Phenolic, Rigid Premolded ASTM C1126 Type III
- F. Type CG: Cellular Glass, Rigid Premolded, ASTM C552 Type II

2.2 JACKETS, FACTORY APPLIED

- A. ASJ (All Service Jacket): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil vapor barrier backing

2.3 JACKETS, FIELD APPLIED

- A. PVC: Polyvinyl Chloride cut and curled sheet, 30 mil.
- B. PW: Asphaltic laminate, fiberglass reinforcement with aluminum-foil vapor barrier, 125 mil heat seal. Basis of design: Pittsburgh Corning PITTWRAP

2.4 FITTING COVERS

- A. PVC, standard duty, factory fabricated, 20 mil, tape secured
 - 1. For protecting or securing insulation only, not for vapor barrier
- B. PVC, heavy duty, factory fabricated, 30 mil, solvent welded for use with field applied PVC jacket

2.5 TAPES, ADHESIVES, COATINGS, FASTENERS

- A. Provide in accordance with insulation manufacturer's specifications and requirements.
- B. Sheet metal screws installed outdoors shall be stainless steel with rubber washers. Galvanized screws shall not be used outdoors.

2.6 LAGGING, FIELD INSTALLED

- A. ALUM: Aluminum, .016" thick, stucco embossed finish. Fasten with aluminum or stainless steel bands on 12" centers. Screws and pop rivets not allowed.
 - 1. For protecting or securing insulation only, not for vapor barrier
- B. FMAS (Flexible Metallic Adhesive System): Self-adhesive embossed aluminum foil sheet, 6.0 mil minimum total thickness. Basis of design: VentureClad 1577CWE

2.7 LAGGING FITTING COVERS

- A. Aluminum, factory fabricated, .024" thick

2.8 MATERIAL PROPERTIES

- A. Insulation material shall satisfy material property requirements of referenced ASTM standard. For convenient summary of referenced ASTM standards see *Insulation Specification Materials Guide* as presented by *National Commercial and Industrial Insulation Association (NIA)*.
- B. All insulation materials, including jackets, tapes, adhesives and coatings, shall meet *ASTM E84 25/50 Flame Spread/Smoke Development* requirements.

Pipe insulation located in ventilation air plenums shall be UL listed for application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Requirements.
 - 1. Install insulation after piping has been inspected and tested. Piping shall be clean, dry and free of rust.
 - 2. Insulate all piping systems conveying fluids with temperature above 105 deg. F, below 60 deg. F or below dew point of ambient air. When fluid is below 60 deg. F or below dew point of ambient air insulation shall have uninterrupted vapor barrier.
 - 3. Insulate all components of piping system for both cold and hot applications. This includes fittings, unions, flanges, strainers, valve bodies and bonnets, flexible connections, flexible hoses, expansion joints and specialties. The common practice of leaving valves, unions, flanges and strainers uninsulated in hot piping systems is not allowed.
 - 4. Do not apply insulation on cold active piping systems, vulnerable to condensation.
 - 5. Do not allow insulation to remain unsealed, vulnerable to entrance of moisture.
 - 6. Provide continuity of insulation and vapor barrier through penetrations unless code prohibits. Ensure openings at penetrations, including roofs and exterior walls, adequate in size to accommodate such continuity.
 - 7. Provide continuity of insulation and vapor barrier through hangers and at supports.
 - 8. Do not use staples or screws to fasten insulation on domestic cold water or other cold piping.
 - 9. Insulate valves in manner that allows full operation without damaging or compromising insulation or vapor barrier.
 - 10. Install metal shields at all hangers and supports. Shields shall be galvanized sheet metal, half round with flared edges. Length and thickness gauge shall be as follows:

Pipe Size	Shield Size
2" and smaller	12" x 20 gauge

Pipe Size	Shield Size
2 ½" – 6"	12" long x 18 gauge
8" to 14"	18" long x 16 gauge
16" to 24"	24" long x 14 gauge

11. Provide high compressive strength inserts or welded steel shoes at hangers and supports to prevent compression of insulation. Inserts shall be same thickness as insulation. Inserts shall be minimum 180 degree minimum cylindrical segments same length as associated metal shield. Rectangular blocks, plugs, or wood material are not acceptable. Inserts and associated jacketing shall be as follows:
- a. Cold water and storm applications
 - 1) ≤ 4 " Pipe, metallic and non-metallic
 - (a) Phenolic (2.5 lb./SF) or cellular glass
 - (b) 6 mil PVDC jacket (e.g. Saran 560)
 - 2) ≥ 6 " Pipe, metallic and non-metallic
 - (a) Phenolic (5.0 lb./SF) or cellular glass
 - (b) 6 mil. PVDC jacket (e.g. Saran 560)
 - b. Hot water applications
 - 1) ≤ 4 " Pipe, metallic and non-metallic
 - (a) Phenolic (2.5 lb./SF) or calcium silicate
 - (b) ASJ or 6 mil. PVDC jacket (e.g. Saran 560)
 - 2) ≥ 6 " Pipe, metallic
 - (a) Welded shoe with insulation fill
(See Section 23 05 29 – Hangers and Supports for HVAC)
 - (b) ASJ jacket
 - 3) ≥ 6 " Pipe, non-metallic (e.g. polypropylene)
 - (a) Phenolic (5.0 lb./SF) or cellular glass
6 mil. PVDC jacket (e.g. Saran 560)
12. Provide high compressive strength inserts at strut-mount pipe clamps to prevent compression of insulation. Inserts shall be phenolic or calcium silicate as appropriate for application. Inserts shall be same thickness as insulation. Insert shall be 360 degree cylindrical segment extending beyond pipe clamp on each side. 180 degree cylindrical shields shall be provided. "Cush-clamps" (e.g. *Unistrut Cush-a-Clamp*) not allowed. In no case shall such be used on cold piping applications.
13. As an alternate to specified support system, *Aeroflex Aerofix-U* polymeric inserts with integral vapor barrier may be used. Metal shields not required when used with strut mount pipe clamp applications (only).
14. As an alternate to specified support system, Hydra-Zorb Klo-Shure insulation coupling may be used. Insulation shall be adhered within coupling to maintain vapor barrier.

15. Ensure piping is supported by specified inserts only. Piping shall not be in direct contact with metallic hangers/supports. Exception: Welded shoe pipe supports on hot piping applications.
 16. Provide heavy duty protective lagging on insulated piping extending to or through floors or curbs. Lagging shall be .032" thick aluminum sheet, mechanically secured. Extend minimum 12" above floor/curb.
 17. Provide protective 30 mil solvent-welded PVC jacket on exposed interior horizontal piping below 2' AFF level and exposed vertical piping below 8' AFF level. Also provide 30 mil solvent-welded PVC jacket on any horizontal piping above 2' AFF that is vulnerable to damage by climbing or stepping.
- B. Specific Requirements for Insulation Type.
1. Type F: Fiberglass, Semi-Rigid Premolded.
 - a. Insulate fittings with field or factory cut fiberglass inserts, multiple inserts may be required. Install PVC fitting covers over insulation. Fasten fitting covers to pipe jacket with PVC tape, both ends. Tacks or staples not allowed.
 2. Type M1: Mineral Wool, Semi-Rigid Premolded
 - a. Insulate fittings with field or factory cut fiberglass inserts, multiple inserts may be required. Install 20 mil PVC fitting covers over insulation. Fasten fitting covers to pipe jacket with PVC tape, both ends. Tacks or staples not allowed.
 3. Type E: **EPDM** Elastomeric Foam, Flexible Tube and Sheet
 - a. Fully adhere insulation to pipe at joints and terminations to prevent moisture transfer along pipe. Adhere around entire circumference of pipe.
 - b. Form fit and fully adhere insulation at valves, strainers, specialties, instrumentation and appurtenances. Fully adhere insulation at all points vulnerable to ingress of moisture.
 4. Type CG: Cellular Glass, Rigid Premolded.
 - a. Install above ground CG insulation with ASJ jacket and vapor barrier mastic.
 - b. Install buried CG insulation with PW jacket per manufacturer's instructions to maintain warranty. Install to adequately accommodate pipe movement. Provide joint sealant (e.g. PITTCOTE) at joints, changes in insulation thickness and terminations.
- C. Additional Requirements for Outdoor Installations
1. Ensure insulation jacket is sealed waterproof, vapor tight.
 2. Provide tightly fitted metal lagging with overlapped sections properly oriented for prevailing winter wind direction (i.e. wind from northwest for central Illinois).
 3. Mechanically attach lagging sections with aluminum or stainless steel bands, 12" on center. Seal all seams and penetrations watertight.

3.2 APPLICATION SCHEDULE

Application	Insulation Type	Thickness Ref.# (see Thickness Schedule)	Jacket / Covering	Lagging
Domestic Cold Water	F or E	(4)	F: ASJ where concealed;	None*

Application	Insulation Type	Thickness Ref.# (see Thickness Schedule)	Jacket / Covering	Lagging
			PVC where exposed E: None	
Domestic Hot Water and Circulation ≥ 105F	F	(1)(2)	ASJ where concealed; PVC where exposed	None*
Domestic Tempered Water and Circulation < 105F	None	NA	NA	NA
Outdoor Domestic Cold Water	E	(4)	None	ALUM or FMAS
Outdoor Domestic Hot Water	F or M1	(1)(2)	ASJ	ALUM or FMAS
Roof Drain (Body)	E	(4)	None	None
Storm Drain (Horizontal Run from Roof Drain to Vertical Riser)	F or M1	(4)	ASJ where concealed; PVC where exposed	None
Plumbing Vent (Within 6 ft. of Roof)	F or M1	(4)	ASJ where concealed; PVC where exposed	None
Cold Condensate Floor Drain (Drain Body)	E	(4)	None	None
Cold Condensate Drain (from Floor Drain to First Pipe Connection)	F or M1	(4)	ASJ where concealed; PVC where exposed	None
Underground Domestic Hot Water (Beneath Floor)	CG	(1)(2)	PW	None

* Provide lagging in areas specified for protection from physical damage.

3.3 THICKNESS SCHEDULE

Application Schedule Reference#	Temp Reference	Minimum Insulation Thickness for Pipe Size				
		3/4" & Smaller	1 - 1 1/4"	1 1/2 - 3"	4 - 6"	8" & Larger
(1)	141-200F	1.5	1.5	2.0	2.0	1.5

(2)	105-140F	1.0	1.0	1.5	1.5	1.5
(3)	61-104F	None	None	None	None	None
(4)	32-60F	1.0	1.0	1.0	1.0	1.0

Notes

1. Manufacturer’s thickness guide or calculation shall be used to determine required minimum insulation thickness for ambient temperature and humidity conditions. Applied insulation thickness shall meet or exceed this value. Thickness may exceed scheduled value.
2. For repairs, insulation thickness shall match existing.

END OF SECTION 220719

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 221000 - PLUMBING PIPING

PART I - GENERAL

1.1 COMPLIANCE

- A. All potable water system components shall be in compliance with *Reduction in Lead in Drinking Water Act*
- B. Potable water system components shall be in compliance with applicable NSF/ANSI Standards.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Pipe and Fittings
 - a. Metallic Pipe and Fittings
 - b. Non-metallic (Polymeric) Pipe and Fittings. Requires Owner approval.
 - 2. Valves
- B. Shut Off Valves

1.3 DISALLOWED PRODUCTS

- A. Roll groove or cut groove joints:
 - 1. Exceptions: Variance required
 - a. In limited areas where hot work is disallowed by Owner
 - b. For limited repair work
- B. Press-connect joints:
 - 1. Exceptions (Variance required):
 - a. In limited areas where hot work is disallowed by Owner.
 - b. For limited repair work
- C. Mechanically formed extruded outlets
- D. Piercing valves and fittings
- E. Saddle connections
- F. Welded branch connections
- G. Reducing bushings and flanges
- H. Dielectric unions or fittings:
 - 1. Exception: In cases where a dielectric fitting is deemed necessary such shall be "*Clearflow*" dielectric nipple. No other manufacturer or product design allowed. Dielectric unions with flexible elastomeric (e.g. rubber, plastic) components not allowed.
- I. Flexible hose:
 - 1. Except final connection to equipment as approved by Owner
- J. Nonmetallic (e.g. polypropylene) piping systems:
 - 1. Except as approved by Owner

- K. Nonmetallic valves
- L. Other non-standard pipe and fittings

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Pipe and tubing shall be transported with ends tightly covered, protected from physical damage. Copper tubing and threaded pipe shall have factory applied end caps maintained in place throughout transportation and storage.
- B. Fittings, valves, specialties and materials shall be transported protected from physical damage and protected from weather.
- C. Large pipe may be stored outdoors on rack or wood blocking with ends tightly covered.
- D. Materials shall be stored indoors protected from temperature, physical damage and exposure to fluids, dust and debris. Containers of solder, brazing and weld consumables, pastes and fluids shall remain sealed until use. Opened containers shall be kept sealed when not in use.

1.5 WARRANTY

- A. Products and installation thereof shall be warranted to be free from defects in material and workmanship for period of one year from date placed into useful service or 18-months from date of delivery, whichever occurs first. Defective product shall be repaired or replaced at no cost to Owner.
- B. Joints shall be warranted to be free from leaks and imperfections for same time period. Defective joint shall be repaired or replaced at no cost to Owner. Impacted piping system shall be manipulated as required to make repair and fluid media shall be brought back to original condition and fill volume at no cost to Owner.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. 175-PSIG, 250-F, Metallic :
 - 1. All Sizes - Copper
 - a. Tubing: Copper, ASTM-B88, Type L, Hard Drawn Seamless
 - b. Fittings: Wrought Copper, ASME-B16.22 or Cast Copper Alloy, ASME-B16.18, Solder Joint
 - c. Pipe nipples: Red Brass, ASTM-B-687, Schedule 80, Seamless, NPT
 - d. Unions: Wrought Copper, ASME-B16.22 or cast Copper Alloy, ASME-B16.18, Solder Joint
 - e. Flanges: Cast Bronze, Class 125, ASME-B16.24, Solder Joint
 - 2. Piping - 1-1/2" and Under:
 - a. Design Pressure/Temperature: 100 psig at 180°F.
 - b. Tubing: Cross-linked polyethylene (PEX), ASTM F876/F877, NSF Certified.
 - c. Joints: Bending the tubing greater than eight (8) times the outside diameter shall be permitted. Bends less than eight (8) times the outside diameter shall be barbed insertion fittings provided by the manufacturer.
 - d. Fittings: Brass or stainless steel with stainless steel or copper crimp ring. Fittings and tubing shall be a system provided by the same manufacturer. Fitting system shall conform to ASTM F1807.

- e. Limitations:
 - 1) Shall only be used for branch runouts to fixtures, above or below grade.
 - 2) Piping and fittings shall be upsized one pipe size to match code-required rough-in size in the State of Illinois (e.g., 1/2" rough-in shall be 3/4" piping and fittings).
 - 3) Shall not be used in a return air plenum unless specifically listed to ASTM E84/UL723.

2.2 VALVES

A. Shut-Off Valves for Plumbing Systems

1. Size 2" and Smaller, Threaded or Solder-End Two-Piece Full-Port Ball Valve
 - a. 600 WOG.
 - b. Shut-off class VI, bi-directional.
 - c. Two-piece cast bronze body.
 - d. NPT or solder connections.
 - e. 316 stainless steel solid tunneled ball (hollow ball not acceptable).
 - f. 316 stainless steel stem and nut.
 - g. PTFE seats.
 - h. Adjustable stem packing.
 - i. Lever handle.
 - j. Insulated piping applications: Provide stem extension. Formed metal extension not acceptable.
 - k. Approved manufacturers: Apollo, Nibco, Watts, Viega.
2. Size 2 1/2" and 3", Threaded or Solder-End Two-Piece Ball Valve.
 - a. 600 WOG.
 - b. Shut-off class VI, bi-directional.
 - c. Two-piece cast bronze body.
 - d. NPT or solder connections.
 - e. 316 stainless steel solid tunneled ball (hollow ball not acceptable).
 - f. 316 stainless steel stem and nut.
 - g. PTFE seats.
 - h. Adjustable stem packing.
 - i. Lever handle.
 - j. Insulated piping applications: Provide stem extension. Formed metal extension not acceptable.
 - k. Approved manufacturers: Apollo, Nibco, Watts, Viega.
3. Size 2 1/2" and Larger
 - a. 200 WOG.
 - b. Shut-off class VI, bi-directional.

- c. Two-piece cast iron or ductile iron body.
 - d. Heat-fused epoxy coating on all interior and exterior surfaces.
 - e. Flanged connections.
 - f. Stainless steel full-port tunneled ball (TFE coated ball not acceptable).
 - g. PTFE seats (Nitrile or EPDM not acceptable).
 - h. Stainless steel stem.
 - i. Adjustable stem packing.
 - j. Lever handle.
 - k. Approved manufacturers: Apollo, Nibco, Watts.
4. Size 2 1/2" through 20", Resilient-Seated Butterfly Valve.
- a. Bi-directional bubble-tight shut-off rating for in-line service as well as dead-end service (with either mating flange removed): 200 PSIG for valves 12" and smaller, 150 PSIG for valves 14" and larger.
 - b. Ductile iron lug style body (cast iron or wafer style body not acceptable).
 - c. Heat-fused epoxy coating.
 - d. EPDM molded-in seat or cartridge-style seat with rigid backing ring (boot-type seat not acceptable).
 - e. Aluminum bronze or stainless steel disc.
 - f. 416 stainless steel shaft.
 - g. Manual actuator:
 - 4) Valves 6" and smaller: 10-position lever handle.
 - 5) Valves 8" and larger: Geared rotary hand-wheel operator.
 - h. Approved Manufacturers: Apollo, Nibco, Watts.

PART 3 - EXECUTION

3.1 PIPE SIZING

- A. Copper piping shall be sized such that fluid velocity does not exceed 4-FPS under any operating condition.

3.2 PIPE AND FITTINGS

- A. Interior of pipe and fittings shall be thoroughly cleaned prior to assembly.
- B. Piping shall be installed plumb and orthogonal relative to floors and walls.
- C. Piping shall be located and configured to avoid interferences and maintain access to devices and equipment requiring service.
- D. Piping shall not be located above electrical panel boards, switchgear, switchboards or motor control centers and shall comply with requirements of the National Electric Code.
- E. Anchors, expansion joints, swing joints and expansion loops shall be provided as required to provide/control movement.
- F. Horizontal mains shall be pitched up 1" per 40' in direction of flow.

- I. Eccentric fittings shall be used for changes in pipe size in horizontal lines and shall be oriented with top of pipe straight.
- J. Elbows and tees shall be long radius type. Short radius not allowed.
- K. Bull-head tee configuration not allowed.
- K. At a minimum, manual isolation valves shall be provided:
 - 1. At branch connections to supply and return mains as indicated on drawings.
 - 2. At supply and return connecting to each unit, device or piece of equipment.
 - 3. At inlet and outlet of each control valve or other automated device.
 - 4. At other locations in piping system as indicated on drawings.
- L. Isolation valves in branch piping shall be located as near connection to mains as practical.

3.3 PIPE JOINING

- A. Soldered, brazed, threaded and welded pipe connections shall comply with requirements of *ASME B31.9*.

3.4 VALVES

- A. Valve Orientation.
 - 1. Ball Valve.
 - a. Valve may be installed in any position except with stem oriented vertically downward (i.e. with handle at bottom).
 - b. Valve shall be installed such that direction of flow indication on valve body and/or product literature, if any, matches the actual direction of fluid flow through valve.
 - 2. Butterfly Valve.
 - a. Valve shall be installed such that shaft is oriented horizontally. In no case shall valve be installed such that the shaft is oriented vertically downward (i.e. with the actuator at the bottom).
 - b. Valve shall be installed such that the direction of flow indication on valve body and/or product literature, if any, matches the actual direction of fluid flow through valve.
- B. Valve Insulation.
 - 1. Insulated piping applications.
 - a. Valves in insulated piping systems shall have body, flanges, etc., completely insulated. The practice of leaving hot water valves and associated unions/flanges un-insulated is not acceptable.
 - b. Insulated valves shall be equipped with extended stems and protective shields as required to allow operation without disturbing insulation.
 - c. Valves shall be provided with lock-out trim where indicated on drawings. Extended stems are not required on valves with lock out trim.

END OF SECTION 22 10 00

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 221123.13 - DOMESTIC WATER PRESSURE BOOSTING SYSTEMS (VFD)

PART 1 - GENERAL

1.1 SUMMARY

- A. Where utility water pressure cannot adequately meet the pressure requirements of the domestic water systems and where it is impractical to have a dedicated pressure booster system serving isolated equipment, furnish and install a factory packaged and tested, duplex variable-speed domestic water pressure boosting system including pumps, motors, controls, valves, interconnecting piping, bypass piping, wiring and accessories for a complete, approved system.

1.2 QUALITY ASSURANCE

- A. The manufacturer of the domestic water pressure boosting system shall be responsible for compliance with all applicable codes and regulations, and be held accountable for the complete pump package and installation.
- B. Manufacturer's Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience. The packaged system manufacturer shall have 24 hour local service available provided by a trained factory authorized representative.
- C. All disconnects, transformers, and control devices shall be installed to provide minimum wire bending clearances per N.E.C. All wiring shall be stranded copper conductors with 90° C. insulation. Conductors shall be numbered and identified at all termination points. All wiring shall be installed in nylon wire ways and laced with nylon tie straps. All disconnects, transformers, controllers, control devices, selector switches, and indicator lights shall be provided with nameplates indicating their respective function and/or identification. A factory wiring schematic shall be permanently affixed to the inside of cabinet door. The entire assembly shall be wired and tested in accordance with the National Electrical Code (N.E.C.). All components shall be built to National Electrical Manufacturers Association (NEMA) standards and be Underwriters Laboratory (U.L.) approved. The entire control panel shall bear the U.L. Label for enclosed industrial control panels. The entire package pumping system shall comply with Federal Regulations 29 CFR 1910.399 and certified through ETL under Category 225 and ULQCZJ.
- D. Installer's Qualifications: The system shall be installed by a firm having proven experience regularly engaged in the installation of variable speed domestic booster pump systems.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Provide manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system with operating point indicated, NPSH curve, controls, wiring diagrams, and service connections. See *Section 01 33 23 – Shop Drawings, Product Data, and Samples*.
- B. Record Documents:
 - 1. See Section 01 78 39 – Project Record Documents.
 - 2. Provide full written description of manufacturer's warranty.

3. Shop Drawings: Indicate layout, general assembly, components, dimensions, weights, clearances, and methods of assembly.
 4. Manufacturer's Installation Instruction: Indicate support details, connection requirements, and include start-up instructions for pump system.
 5. Manufacturer's Certificate: Certify that pumps meet or exceed specified requirements at specified operating conditions. Submit summary and results of factory tests performed.
 6. Field Reports: Submit verification statement, signed by system manufacturer representative, of start-up, adjustment service and acceptance of installation. Indicate summary of hydrostatic test and field acceptance tests performed.
- C. Operation and Maintenance Data:
1. See Section 01 78 23 – Operation and Maintenance Data.
 2. Operation Data: Include manufacturer's instructions, start-up data, trouble-shooting check lists, for pumps, drivers, and controllers.
 3. Maintenance Data: Include manufacturer's literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers, preventive maintenance schedule, preventive maintenance recommendations and procedures. Identify place of purchase, location and contact numbers of service depot and technical support for each product installed.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Accept pumps and components on Site in factory packing. Inspect for damage. Comply with manufacturers rigging and installation instructions.
- B. Protect pumps and components from physical damage including effects of weather, water, and construction debris.
- C. Provide temporary inlet and outlet caps, and maintain in place until installation.

1.5 MAINTENANCE SERVICE

- A. Furnish service and maintenance of packaged system for one year from date of Substantial Completion.

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.
- B. Pressure ratings of pumps, pipe, fittings, valves, gauges and all other water carrying appurtenances shall be suitable for the anticipated system pressures in which they are installed.
- C. The Contractor shall ascertain for himself the space and access available for the installation of a factory assembled packaged unit and as an option may assemble the various components in place at the Site in lieu of providing a factory assembled unit. However, all components of the system shall be compatible and be furnished by a single source manufacturer and all electrical services and interconnecting equipment wiring must be provided for within this Contractors bid.

- D. The booster system shall be factory assembled on a steel skid including pumps, motors, butterfly shut-off valves, wafer style silent check valves, Type "L" copper or Schedule 40 300 series stainless steel suction and discharge manifolds, all interconnecting piping, wiring, variable frequency drives with logic and power controls.
- E. Provide hydro-accumulator tank that will allow the pumps to shut down during low flow conditions.
- F. All pilot lights and visual indicators shall be illuminated from the rear by long life LED lamps. Neon and incandescent lamps are not acceptable.
- G. Provide isolation valves on the suction and discharge of each pump. The isolation valves shall be 600 WOG full-port ball valves (2" and smaller) and lug style butterfly valves (2½" and larger).
- H. Provide two 4 1/2" ASME grade A, panel mounted gauges for indicating system suction and system discharge pressure.
- I. All skid-mounted components shall be factory finished in high quality epoxy or enamel paint. The base shall be suitable for grouting.
- J. The packaged pumping system shall include all electrical wiring between components and shall be completed and tested at the factory prior to shipment.
- K. Unions or flanges shall be provided for easy removal of pumps. Pipe headers shall be sized for a velocity not exceeding 7-1/2 FPS and shall be terminated with a groove joint capable of accepting a groove coupling or groove flange furnished by Contractor.
- L. System shall be arranged such that single point connections are required for piping and electrical power supply.
- M. Individual pumps, motors and pressure regulating or check valves shall be serviceable with the booster system in operation.
- N. All similar components shall be of one manufacturer, (i.e., valves, gauges, etc.).
- O. Refer to schedules on Contract Drawings for required pump capacities and electrical characteristics.

2.2 ACCEPTABLE MANUFACTURERS

- A. The following manufacturers are acceptable provided their products meet or exceed these Specifications and the Contract drawing schedules:
 - 1. Patterson Pump, Aqua FloPak
 - 2. Bell and Gossett
 - 3. Armstrong
 - 4. Metropolitan
 - 5. Aurora

2.3 PUMPS AND MOTORS

- A. System shall include two horizontal mounted close-coupled end suction centrifugal pumps with ANSI flanged connections. Pump features to include foot supported casing, back pull out design, top centerline discharge and hydraulically balanced impeller. Pump shall be cast iron bronze fitted or stainless steel construction with a replaceable shaft sleeve and mechanical seal with carbon-ceramic seal faces.
- B. Each pump shall be provided with an individual temperature probe and purge valve having adjustable high temperature set point and differential to sense heat buildup in the pump casing. On sensing high temperature the probe circuit shall open a solenoid valve that allows the heated water to flow out.

2.4 VARIABLE FREQUENCY DRIVES

- A. See Section 26 29 23 – Variable Frequency Drive Controllers for VFD requirements.

2.5 PRESSURE SENSOR/TRANSMITTER

- A. Provide one pressure sensor/transmitter that provides a 4 to 20 mA DC output, compatible with the system controls, temperature and pressure requirements. Pressure sensor/transmitter shall have zero, span and damping devices. The transmitter shall be installed on the system discharge header and factory wired to the control panel.

2.6 SEQUENCE OF OPERATION

- A. The lead pump shall run only as necessary to maintain system pressure and will be controlled automatically by means of a pressure sensor/transmitter and programmable logic controller (PLC) programmed to prevent short cycling. If the lead pump is unable to maintain system pressure the lag pump(s) will be called on after a time delay and will operate in parallel with the lead pump in accordance with the PLC program. When one pump can handle the system demand the controls will shut down the lag pump. When a low or no flow condition is reached, the controls will accelerate the lead pump to charge the system and hydro-accumulator tank then shut the lead pump down and alternate.

2.7 CONTROL PANEL

- A. Logic Section - Provide, mount and wire on the skid a programmable logic controller in a NEMA 1 enclosure to interface the signal from the pressure sensor to the VFD's and provide a stabilized response to speed up or slow down or add pumps to meet system requirements. The controller shall provide setpoint adjustment, timer adjustment, PID functions and both system and controller self-diagnostics via touch screen display. The touch screen display / human machine interface shall include a 5.7" (minimum) STN display, resistive analog touch, numerical system keyboard. All user interface set points shall be easily accessible via a password protected display screen. Normal system operation shall be tuned to eliminate hunting. Controller shall have one RS 485 Communication port, real time calendar/clock and EEPROM memory transfer cartridge.
- B. Power Section - Each system shall include a UL listed enclosed industrial control panel in a NEMA 1 enclosure, factory wired and mounted on the steel skid. The panel shall be furnished with individual pump disconnects with through the door handles, pump run lights, H-O-A selector switches and 115 volt fused control transformer and include the following features:
 - 1. Control power (on-off) switch and light.

2. Low suction pressure shutdown circuit with auto reset, delay timer and light.
3. High system pressure shutdown circuit with auto reset and light.
4. Power failure monitoring.
5. Audible alarm with silence push button.
6. Auto alternate three equal pumps.
7. Auxiliary relay contacts for all alarm conditions.
8. PLC enable switch.
9. Individual pump temperature probe and purge valves.
10. Main Disconnect.
11. Audible and visual indication of low storage tank level (signal by others), with silence push button.
12. Elapsed time meters.
13. Flow sensor with digital display in GPM.
14. Seven day time clock for intermittent system operation.

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.
- B. Install the system level and in accordance with manufacturer's published recommendations.
- C. Locate equipment with allowance for manufacturer's recommended clearances around unit.
- D. Set entire unit on 4" high reinforced concrete equipment pad. Provide vibration isolators and bolt skid to pad. Structurally connect equipment pad to building slab to prevent movement.
- E. Pipe discharge from all relief valves, drains and individual pump thermal purge protection solenoid valves, indirectly to floor drain having adequate capacity to accept discharge.
- F. Provide valved Type "L" copper branch feed to the bladder tank from system distribution main as shown on the Contract Drawings.

3.2 FACTORY TESTING

- A. The booster system shall be hydrostatically tested and shall undergo a complete electric and hydraulic test from 0 to 100% design flow at the factory. All control devices including transmitters and all safety features shall be factory calibrated and tested.

3.3 VERIFICATION AND TESTING

- A. Verify that the pumps and prime movers have been aligned according to manufacturers' recommendations. Test the system performance by verifying the operation of the pumps and system vs. the pump curves, alarms, controls, etc.

3.4 INSTRUCTIONS AND START-UP

- A. Provide for the service of a competent factory-trained supervising agent from the pump package manufacturer to inspect the completed installation, start the system and acquaint the operators with the proper operation and maintenance of the equipment.

END OF SECTION 221123.13

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 221316 - SANITARY WASTE AND VENT AND STORM PIPING

PART 1 - GENERAL

1.1

PART 2 - PRODUCTS

2.1 SANITARY SEWER PIPE MATERIAL

- A. PVC, CPVC, and cast iron piping are permitted within buildings for sanitary lines. Use ASTM C1540 Heavy-Duty Shielded Couplings with no-hub cast iron piping.
- B. Kitchen sanitary sewer piping shall be stainless steel. PVC may be used for grease vent piping unless in a return air plenum.
- C. Laboratory sanitary sewer piping material shall be PP or PVDF. Piping located above accessible ceilings shall have mechanical joints. Piping located above hard ceilings, within walls and in inaccessible chases shall have electro-fusion joints.
- D. Buried sanitary sewer piping outside of the building that is under gravity flow shall be PVC.

2.2 STORM SEWER PIPE MATERIAL

- A. Storm sewer piping above ground shall be cast iron or PVC. Cast iron shall be used in supply air and return air plenums.
- B. Cast iron pipe shall be hub and spigot type or no-hub type. Use ASTM C1540 Heavy-Duty Shielded Couplings with no-hub cast iron piping. Provide fitting restraints for cast iron piping systems. PVC shall have solvent cemented joints.
- C. PVC shall be insulated if located in areas where noise may be an issue.
- D. Buried storm sewer piping outside of the building that is under gravity flow shall be PVC.

PART 3 - EXECUTION

3.1

END OF SECTION 221316

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 221329 - SANITARY AND STORM SEWER PUMPS

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 GENERAL

- A. Sanitary or storm sewer sumps that receive any solid waste or that have sumps deeper than 5 feet shall incorporate duplex self-priming sewage pumps by Gorman-Rupp, Hydromatic, ITT Flygt, or Metropolitan.
- B. Sanitary or storm sewer pumps within sumps no deeper than 5 feet receiving only liquids and no rainwater shall be submersible type as manufactured by Blue Angel, Flygt, Grundfos, and Zoeller.

2.2 SANITARY AND STORM SEWER PUMP REQUIREMENTS

- A. Main sanitary and storm sewer sumps shall have duplex pumps.
- B. Sump pits shall be fiberglass with fiberglass anti-floatation flanges. A concrete collar shall be poured around the flanges.
- C. Pit cover shall be bolted, powder coated or epoxy coated steel gasketed cover with inspection access plate and all other necessary access plates and openings. Cover shall be rated for no less than 300 pounds per square foot.
- D. Pump controls shall consist of the following:
 - 1. Four (4) non-mercury weighted float switches installed in pit. Switches shall be anchored to a 316 stainless steel support.
 - 2. NEMA-1 UL labeled/listed duplex control panel with a lockable main door. All circuit breakers, disconnects and starters shall be NEMA rated. Panel shall contain the following:
 - a) Top mounted high water alarm light.
 - b) High water alarm horn and silencing switch.
 - c) Panel Mounted Lights: Pump 1 Fail, Pump 2 Fail, Pump 1 Run, Pump 2 Run.
 - d) Two (2) circuit breakers.
 - e) Two (2) disconnect switches.
 - f) Two (2) NEMA-sized starters.
 - g) Overload blocks.
 - h) Fuse blocks.
 - i) Two (2) HOA switches.
 - j) Automatic alternator.

- k) Elapsed time meter for each pump.
- l) Minimum of two (2) control transformers.
- m) Microprocessor-based logic controller. Unit shall provide seven (7) alarm codes for personnel to monitor.
- n) High water alarm contact for connection to Building Automation System.

2.3 ELEVATOR-RELATED REQUIREMENTS

- A. Installation of Sump Discharge lines shall be coordinated with Elevator Contractor before installation.
- B. Elevator Sump Pumps are required by Elevator Code to be rated at 3000 gph and be provided one sump and pump per elevator including hoistways with multiple elevators installed.
- C. Hydraulic elevator sump pumps: Sump pumps installed in hydraulic elevator pits shall be provided so that they will not pump or discharge any types of oil. Water only sump pumps shall be used in all hydraulic elevator pits and will continue to pump water down to the level of oil as water infiltrates into the elevator pit.
- D. Elevator Pit Sump Pump Service: A submersible type pump shall be used. It shall be provided complete with following items:
 - 1. Manual test button and waterproof cord and plug
 - 2. Ball valve, check valve and union in discharge line.
- E. Fiberglass or formed concrete sump pit. Fiberglass sump pit shall have fiberglass anti-floatation flange. A concrete collar shall be poured around the flange.
 - 1. Flush fitting pit cover perforated to accept drainage. Cover shall be bolted, powder coated or epoxy coated steel and shall be rated for no less than 300 pounds per square foot.
 - 2. Sump Discharge shall not be located within the elevator machine room.
 - a. Under no circumstances shall elevator pits be used as a collection basin for any type of drainage. The elevator pit shall contain a sump pit with sump pump.
 - b. Discharge Lines: Elevator pit sump pumps shall be routed so that they are not a tripping hazard, will not take up any elevator pit refuge space and installed against a wall or other location where they will not interfere with any equipment or personnel working in the elevator pit area. Placement of the discharge line must be coordinated with the elevator contractor for clearance and equipment requirements. Discharge shall be into a sanitary sewer hub drain within a mechanical room.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide separate electrical feeds for each pump motor with separate disconnecting means to allow for servicing motor without interrupting the operation of the other motor. Control circuits shall likewise be capable of independent operation.

- B. Pumps shall be connected to emergency power system when available.
- C. A high water float switch and alarm bell shall be provided for each sewage ejector or sump pump. This alarm shall connect to the Building Automation System.
- D. It is preferred that discharge from sanitary sewer and storm sewer pumps shall be taken directly to an external manhole without connecting to gravity drained lines prior to the manhole.

END OF SECTION 221329

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 224000 - PLUMBING FIXTURES

PART I - GENERAL

1.1 SPECIFICATIONS

- A. Plumbing fixture specifications shall be based on availability of repair and replacement parts and shall be centered on major manufacturer listings.

PART 2 - PRODUCTS

2.1 WATER CLOSET

- A. Water closet shall be 500 pound (minimum) rated, vitreous china, 4-bolt wall mounted, elongated bowl, siphon jet, minimum 2 1/8" thoroughly and fully glazed trapway, 1 1/2 inch top spud, white, open front, heavy duty, anti-microbial, non-slamming seat, less cover, with concealed check hinge. NO WASHOUT CLOSETS WILL BE PERMITTED. Water closet shall be mounted on floor mounted, 500 pound (minimum) rated carriers set in concrete masonry unit walls with the carrier grouted into the wall for added rigidity. Rim height shall be 15" for normal use and 17" for accessible use.
- B. Approved water closet seat manufacturers shall be Bemis (2155SSCT), Olsonite, Church and Beneke.
- C. Approved water closet manufacturers shall be American Standard, Kohler, Zurn, Sloan, and Toto.
- D. Flush valve can be manual or sensor type. Sensor type valve shall be solar-powered with battery backup, and shall have manual override flush activator button, concealed screwdriver angle stop, and chloramine resistant internal seals and components similar to Sloan SOLIS.
- E. Approved flush valve manufacturers shall be Sloan, Zurn and Toto.

2.2 URINAL

- A. Urinal shall be vitreous china, low flow style, with extended shields and trap, wall hanger, vandal resistant outlet strainer, 3/4 inch top spud, 2 inch I.P.S. outlet connection, open passageway. Urinal shall be mounted on floor mounted carrier set in concrete masonry unit wall with the carrier grouted into the wall for added rigidity. Urinal should have an open throat that is free of trapping mechanisms. A concealed rim at the front of some urinals are found to become a collection point for urine, resulting in additional odor.
- B. Approved urinal manufacturers shall be American Standard, Kohler, Zurn, Sloan, and Toto.
- C. Flush valve can be manual or sensor type. Sensor type valve shall be solar-powered with battery backup, and shall have manual override flush activator button, and chloramine resistant internal seals and components similar to Sloan SOLIS.
- D. Approved flush valve manufacturers shall be Sloan, Zurn and Toto.

2.3 LAVATORY

- A. Lavatory shall be wall mounted vitreous china with back and drillings for concealed arm carrier. The flow through each lavatory supply shall be 0.5 GPM. Lavatory shall be mounted on floor mounted concealed arm carrier set in concrete masonry unit wall with the carrier grouted into the wall for added rigidity. Counter mounted lavatories are prohibited.
- B. Approved lavatory manufacturers shall be American Standard, Kohler, Zurn, Sloan, and Toto.
- C. Faucet can be manual or sensor type. Approved faucet manufacturers shall be Moen Commercial, Zurn, T&S Brass and Bronze Works, Inc., and Chicago Faucets. Faucets shall be ANSI/NSF 61, Section 9 certified. Manual faucets shall incorporate 1/4-turn ceramic cartridge with

¼-turn ceramic stops. Single hole style lavatory faucets are preferred. Sensor type faucets shall be battery powered or hard-wired.

- D. Lavatory Drain and Trap: 17 gauge chrome plated cast brass grid drain assembly with 1-1/4" tailpiece; 17 gauge 1-1/4" x 1-1/2" chrome plated cast brass P-Trap with cleanout; 17 gauge chrome plated cast brass tubing outlet with wall flange. All slip nuts on the assembly shall be chrome plated cast brass. Die-cast slip nuts are unacceptable.
- E. Approved lavatory drain and trap manufacturers shall be McGuire, Keeney, and Dearborn Brass. Lavatory Stops and Supplies: Chrome plated angle pattern stops, lock shield cap, loose key handle, with cast bronze valve bodies, stems, and gland nuts, 5/8" compression inlet x 3/8" compression outlet. Supplies shall be chrome plated copper tube.
- F. Approved lavatory stops and supplies manufacturers shall be Chicago Faucet (1025-ABCP Series), McGuire, and Keeney
- G. Drain and Trap for Lavatory Mounted at Accessible Height: 17 gauge chrome plated cast brass grid drain assembly with wheelchair offset and 1-1/4" tailpiece; 17 gauge 1-1/4" x 1-1/2" chrome plated cast brass P-Trap with cleanout; 17 gauge chrome plated cast brass tubing outlet with wall flange. All slip nuts on the assembly shall be chrome plated cast brass. Die-cast slip nuts are unacceptable. Provide insulation kit for coverage of drain assembly and hot water and cold water supplies.
- H. Approved accessible height lavatory drain and trap manufacturers shall be McGuire, Keeney, and Dearborn Brass.
- I. Approved accessible height lavatory insulation kit manufacturers shall be Truebro (Model #103 E-Z), McGuire, Keeney, and Plumberex.

2.4 MOP BASIN

- A. Mop basin shall be floor level type precast terrazzo mop basin with stainless steel cap.. Faucet shall have adjustable integral stop arms, pail hook, brace, vacuum breaker, and 3/4-inch hose thread outlet. Supply arms of faucet shall come with integral check valves to prevent backup of HW into the CW main. Provide hose and hose bracket, mop hanger with 3 spring loaded rubber grips, and stainless steel wall guards with unit.
- B. Approved mop basin manufacturers shall be Fiat, Acorn, Stern-Williams, and Florestone.
- C. Approved mop basin faucet manufacturers shall be Moen Commercial, Zurn, T&S Brass and Bronze Works, Inc., and Chicago Faucets.

2.5 SHOWER ENCLOSURE

- A. Shower enclosure generally will be constructed in place, with membrane waterproofing in the walls and floor. In the event a precast receptor is used for an individual shower, it shall have integral membrane waterproofing and special care shall be taken to finish the wall membrane waterproofing over the top rim of the receptor. Lead safing pans for showers shall not be used. Strainer shall have a minimum free flow area of 13.25 square inches.

2.6 MIXING VALVE AND SHOWER HEAD

- A. Mixing valve and shower head shall be for concealed piping, consisting of built-in shutoff valve, integral volume and temperature control, maximum temperature stop, 1/2 in. pipe connections, shower set with chrome plated arm, flange and self-cleaning circular off-the-wall shower head with ball joint, separate spray control maximum 2.0 GPM delivery rate, inlet screwed end stop valves.

2.7 ACCESSIBLE SHOWER STALLS

- A. Same as above except to further include a lever diverting valve, 60 inch reinforced braided hose, spray head, atmospheric vacuum breakers, and wall hook assembly. Special arrangement of the

curb, shower enclosure and trimming is required in a residence hall shower for students using wheel chairs. Refer to ANSI A117.1-1986.

2.8 SAFETY SHOWER AND EYEWASH STATION

- A. A safety shower with floor drain and eyewash station shall be located in every laboratory and shall be installed to be immediately available or within 25 feet of the fume hood. This equipment shall be clearly identified for that purpose.
- B. Conflicts with cabinetry, electrical devices, equipment, etc., shall be eliminated.
- C. The water supply to the safety shower and eyewash area shall be situated to avoid problems with stagnant water in the line. Connect to high use water lines. Water shall be delivered between 75 and 100 degrees F.

2.9 SERVICE SINK

- A. Service sink shall be size 24" x 20", acid resisting enameled cast iron, stainless steel rim guard, standard trap enameled inside with strainer.

2.10 SILLCOCK

- A. Sillcock shall be of the non-freeze integral vacuum breaker type, ceramic disc cartridge, and shall be arranged around outside of building so that 100 ft. of the hose shall reach all portions of the perimeter. Each sillcock will have its own isolation valve inside the building. PEX piping shall directly feed the sillcock from the isolation valve to minimize risk of freezing and breaking water lines.

2.11 ELECTRIC WATER COOLER

- A. All shall be accessible type units. Mount higher if not required for accessible use. Individually wall surface mounted type with stainless steel receptors, stainless steel cabinets, flexible bubblers, and bottle filler (only one is needed if two water coolers are installed next to each other). Use Elkay, Halsey Taylor, or Oasis units only (to match University stock units). Mount units on floor mounted carriers. Refer to ADAAG and ANSI A117.1.
- B. The water supply to the electric water coolers shall come from a high use point of the main water supply. Do not connect drinking fountains to "dead end" branches of the building water supply distribution system. "Dead end" branches of the water supply and oversized feeds tend to promote the formation of bad tastes and odors in drinking water.
- C. Drain and Trap: 17 gauge 1-1/4" x 1-1/4" chrome plated cast brass P-Trap with cleanout; 17 gauge chrome plated cast brass tubing outlet with wall flange. All slip nuts on the assembly shall be chrome plated cast brass. Die-cast slip nuts are unacceptable.
- D. Approved electric water cooler drain and trap manufacturers are McGuire, Keeney, and Dearborn Brass.
- E. Electric Water Cooler Stop and Supply: Chrome plated angle pattern stop, lock shield cap, loose key handle, with cast bronze valve body, stem, and gland nut, 5/8" compression inlet x 3/8" compression outlet. Supply shall be chrome plated copper tube.
- F. Approved electric water cooler stop and supply manufacturers shall be Chicago Faucet (1025-ABCP Series), McGuire, and Keeney.

2.12 FLOOR DRAIN

- A. Floor drain shall be cast iron unless acid resistance is necessary. Floor drain shall be installed such that the surrounding floor slopes to the floor drain. Floor drains that are used infrequently, such as in a restroom or mechanical room, shall have a deep seal trap. Trap primers are not allowed.

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION 224000

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 2305 19 - METERS AND GAUGES FOR HVAC PIPING

PART I – GENERAL

1.1 SUMMARY

- A. This section includes the following:
1. Thermometers
 2. Pressure Gauges
 3. Pressure/Temperature (P/T) Plugs
 4. Venturi Flow Elements

1.2 DEFINITIONS

- A. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
- a. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
 3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.
- B. Abbreviations:
1. %: Percent.
 2. ANSI: American National Standards Institute.
 3. ASME: The American Society of Mechanical Engineers.
 4. E.g.: Exempli gratia “for example.”
 5. Etc.: Et cetera “and other similar things”
 6. F: Degrees Fahrenheit.
 7. FPS: Feet per second.
 8. FT or ‘: Feet.
 9. HVAC: Heating, Ventilating, and Air-conditioning.
 10. In or “: Inches.
 11. NPT: National pipe thread.
 12. PSC: Professional Service Consultant such as engineer, architect, etc.
 13. PSIG: Pounds-per square-inch gauge pressure.

14. P/T: Pressure / temperature.
15. UIS: The University of Illinois at Springfield.

1.3 QUALITY ASSURANCE

- A. Installation and operation shall be in compliance with Manufacturer's recommendations, requirements, and installation, operations, and maintenance manuals.
- B. SUBMITTALS
 1. Manufacturer's data
 2. Detailed specifications
 3. Dimensioned drawings
 4. Selection guide
 5. Project application schedule
 6. Installation, operation and maintenance manual

PART 2 - PRODUCTS

2.1 STEM TYPE THERMOMETERS FOR PIPELINE AND TANK MOUNTING

- A. Liquid-in-Glass Thermometer
 1. Case: Cast aluminum
 2. Lens
 - a. Acrylic, polycarbonate or glass for ranges to 300-degrees-F
 - b. Glass for ranges over 300-degrees-F
 3. Scale: 9"
 4. Accuracy: 1 scale division
 5. Stem configuration
 - a. Fully adjustable in multiple planes
 - b. Extended as required to clear insulation
 6. Stem length
 - a. Pipe application: Insertion to approximate midpoint of pipe but no less than 1/3-pipe diameter
 - b. Tank application: Minimum insertion length of 5"
 7. Thermowell
 - a. Brass or stainless steel construction as appropriate for process fluid. Rated for 27-FPS fluid velocity
 - b. With "lagging extension" for insulated piping
 - c. With flange for duct mounting
 8. Temperature range: Selected for normal reading near center of scale, for example...
 - a. Chilled water: 0-100-degrees-F
 - b. Condenser water: 0-160-degrees-F
 - c. Heating hot water: 30-240-degrees-F

- d. Steam condensate: 30-300-degrees-F
 - e. Steam, low pressure: 50-300-degrees-F
 - f. Steam, medium-high pressure: 50-500-degrees-F
9. Manufacturers
- a. Ashcroft
 - b. Trerice
 - c. Reotemp
 - d. Wika
 - e. Wexler
- B. Bimetallic Dial Thermometer
- 1. Case and ring: Hermetically sealed stainless steel, 5"
 - 2. Lens: Anti-parallax glass
 - 3. Dial face: Aluminum
 - 4. Accuracy: 1 scale division, field re-calibrate-able
 - 5. Connection: 1/2" NPT stainless steel
 - 6. Stem: 1/4" stainless steel
 - 7. Bracket
 - a. Fully adjustable in multiple planes
 - 8. Extended as required to clear insulation
 - 9. Stem length
 - a. Pipe application: Insertion to approximate midpoint of pipe but no less than 1/3-diameter of pipe
 - 10. Tank application: Minimum insertion length of 5"
 - 11. Thermowell:
 - a. Brass or stainless steel construction as appropriate for process fluid. Rated for 27-FPS fluid velocity
 - b. With "lagging extension" for insulated piping
 - c. With flange for duct mounting
 - 12. Temperature range: Selected for normal reading near center of scale, for example...
 - a. Chilled water: 0-100-degrees-F
 - b. Condenser water: 0-160-degrees-F
 - c. Heating hot water: 30-240-degrees-F
 - d. Steam condensate: 30-300-degrees-F
 - e. Steam, low pressure: 50-300-degrees-F
 - 13. Manufacturers
 - a. Ashcroft
 - b. Trerice

- c. Reotemp
- d. Wika
- e. Wexler

2.2 PRESSURE GAUGES FOR HVAC APPLICATIONS

A. Pressure Gauge for Hydronic and Steam Applications

1. ANSI Grade 1A ($\pm 1\%$ of span)
2. 4-1/2" dial
3. 1/4" NPT lower connection
4. Weather-proof stainless steel or polypropylene case
5. Stainless steel or polypropylene ring
6. Laminated safety glass or acrylic window
7. Stainless steel movement
8. Bronze tube and brass socket
9. Micro-adjustable knife edge pointer
10. Glycerin liquid filled
 - a. Hydronic, compressed air and gas applications, 0-250-degrees-F
11. Dry type
 - a. Applications above or below this temperature range
 - b. Steam applications
12. Pressure range: Selected for reading near center of scale, for example:
 - a. Chilled water, central: 0-160-PSIG
 - b. Chilled water, dedicated: 0-100-PSIG
 - c. Condenser water: 0-100-PSIG
 - d. Heating hot water: 0-100-PSIG
 - e. Steam, low pressure: 0-30-PSIG
 - f. Steam pumped condensate: 0-100-PSIG
13. Manufacturers
 - a. Ashcroft
 - b. Trerice
 - c. Reotemp
 - d. Wika
 - e. Wexler

B. Pressure Gauge for Air Applications

1. Die cast aluminum case and bezel with acrylic cover
2. 4" dial face
3. Accuracy: $\pm 2\%$ full scale

4. 1/8" female NPT duplicate high and low pressure taps
5. Adjustable signal pointer
6. Pressure range: Selected for reading near center of scale
7. Stand-off mounting bracket as required to accommodate insulation
8. Duct connector and tubing kit
9. Basis of Design
 - a. Dwyer / Series 2000 Magnehelic

2.3 PRESSURE/TEMPERATURE TEST PLUGS

A. P/T Test Plug

1. 1/4" or 1/2" brass body and cap
2. Body length:
 - a. 1-1/2" for uninsulated piping applications
 - b. 3" for insulated piping applications
3. Nordel core for receiving 1/8" diameter pressure and temperature probes. Nordel shall be used for all temperature ranges.
4. Rated for 500-PSIG / 275-degrees-F
5. Rated for zero leakage over published range

2.4 VENTURI FLOW ELEMENT

A. 2" and Smaller

1. Forged brass body
2. NPT connections
3. 400-PSIG / 250-degrees-F rating
4. 250-degrees-F temperature rating
5. Venturi inner flow nozzle
6. Temperature Rating: 250-degrees-F
7. Pressure test ports with Nordel cores (per Paragraph 2.3 *P/T Test Plug* specification above)
8. Accuracy: 1%
9. Straight-run pipe requirement shall not exceed 5-diameters upstream and 2-1/2 diameters downstream.
10. Manufacturers:
 - a. Griswold
 - b. Macon
 - c. Presso
 - d. Badger

B. 2-1/2" and Large

1. Carbon steel body
2. Flanged connections

3. 240-PSIG / 250-degrees-F rating
4. Venturi internal flow nozzle
5. Piezo ring dual chamber design for signal averaging
6. Pressure test ports with Nordel cores (per P/T test plug specification found elsewhere in documents)
7. Accuracy: 1%
8. Straight-run pipe requirement shall not exceed 5-diameters upstream and 2-1/2 diameters downstream.
9. Manufacturers:
 - a. Griswold
 - b. Macon
 - c. Presso
 - d. IMI Flow Design

PART 3 - EXECUTION

3.1 INSTALLATION

A. Thermometers

1. Provide thermometers as shown on drawings. Selection of thermometer type may be based upon location or application.
2. Locate and position thermometer for ease of viewing.
3. Specific orientation requirements:
 - a. Large pipe applications (10" diameter and larger): Orient stem 45-degrees from bottom of pipe.
 - b. Small pipe applications: Install thermometer at 90-degree elbow location. Orient stem collinear with centerline of pipe.
4. Provide separable thermowell unless otherwise indicated in project documents.
5. Coat last two inches of stem with non-hardening heat-conducting compound suitable for measured temperature range.
6. Trim and seal surrounding insulation. Ensure vapor barrier integrity. Apply approved mastic as required to maintain vapor barrier.

B. Pressure Gauges

1. Provide pressure gauges as shown on drawings.
2. Position gauge for ease of viewing.
3. Provide pulsation dampener (aka "snubber") at pump discharge locations. Avoid dampeners at other locations (they are prone to stopping up).
4. Provide siphon (aka "pigtail") at each steam pressure indicating gauge.
5. Provide shut-off valve for each gauge. Use ball valve for hydronic or steam service as specified in 23 21 13 – *Hydronic Piping* or 23 22 13 - *Steam and Condensate Piping*. Valve may be standard port or full port design. Locate valve as near system main as practical.
6. Use 1/2" schedule 80 steel pipe nipple from pipe connection to valve.

7. Where gauge piping is connected to equipment (e.g. pump, suction diffuser, etc.) use "connection size" schedule 80 steel pipe from equipment connection to valve. Use 1/2" copper or stainless steel tubing from valve(s) to gauge.
- C. Pressure Temperature Test Ports (P/T Plugs)
1. Provide P/T plug in supply and return piping at each terminal unit throughout hydronic system in addition to P/T plugs shown on drawings.
 - a. "Terminal unit" shall include but not be limited to reheat coil, finned tube element, unit heater, convector, fan coil unit, water cooled condenser, laboratory and process equipment, etc.
 2. Additionally, provide P/T plugs at all other locations shown on drawings.
 3. Locate and orient P/T plug for ease of access.
 4. Avoid orienting P/T plug downward (to prevent fouling with sediment).
- D. Venturi Flow Elements
1. Provide flow elements as shown on drawings.
 2. Locate and orient flow element for ease of access.
 3. Provide manufacturer's required straight-run piping at a minimum.

END OF SECTION 230519

- . This section of the *UIS Facilities Standards* establishes minimum requirements only. It should not be used as a complete specification.

SECTION 230593 - TESTING ADJUSTING AND BALANCING FOR HVAC

PART I - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Heating Contractor provides:
 - a. Testing, adjusting, and balancing of heating and plumbing systems.
 - b. Testing, adjusting, and balancing of cooling systems.
 - c. Measurement of final operating condition of HVAC systems.
 - d. Participation in commissioning process.
 - 2. Ventilation Contractor provides:
 - a. Testing, adjusting, and balancing of air systems.
 - b. Measurement of final operating condition of HVAC systems.
 - c. Participation in commissioning process.

1.2 DEFINITIONS

- A. Abbreviations:
 - 1. %: Percent
 - 2. AABC: The Associated Air Balance Council
 - 3. AHU: Air-handling unit
 - 4. AMCA: Air Movement and Control Association
 - 5. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
 - 6. BAS: Building Automation System.
 - 7. Btuh: British thermal units per hour
 - 8. CFM: Cubic feet per minute
 - 9. Cv: Valve coefficient
 - 10. DB: Dry bulb temperature.
 - 11. DDC: Direct digital control
 - 12. E.g.: Exempli gratia "for example"
 - 13. Etc.: Et cetera "and other similar things"
 - 14. F: Degrees Fahrenheit.
 - 15. GPM: Gallons per minute
 - 16. HVAC(&R): Heating, Ventilating, and Air-conditioning (and Refrigeration)
 - 17. I.e.: Id est "in other words"
 - 18. NEBB: National Environmental Balancing Bureau
 - 19. NIST: National Institute of Standards and Technology
 - 20. PSC: Professional Service Consultant such as engineer, architect, etc.

21. RPM: Revolutions per minute
22. SMACNA: Sheet Metal and Air-conditioning Contractor's National Association
23. TAB: Testing, adjusting, and balancing
24. TABB: Testing, Adjusting and Balancing Bureau
25. UIUC or U of I: The University of Illinois at Urbana-Champaign
26. VFD: Variable frequency drive
27. WB: Wet bulb temperature

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance.
- B. AMCA – Publication 203-90; Field Performance Measurement of Fan Systems.
- C. ASHRAE - HVAC Applications Handbook; Testing, Adjusting and Balancing.
- D. ASHRAE/ANSI - Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.
- E. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
- F. SMACNA - HVAC Systems; Testing, Adjusting and Balancing.
- G. TABB – International Standards for Environmental Systems Balance.

1.4 SUBMITTALS

- A. Submit hardcopy and electronic copies of report forms, balancing procedures, TAB Plan and the name and qualifications of testing and balancing agency for approval within 30-days after award of Contract.
- B. Identify as "Draft copy of Balancing and Testing Report - for Approval" on Transmittal with relevant numbering as required on Project Submittals. Include items from (A) and the requirements from this Specification, related sections including but not limited to 01 93 23 - General Commissioning Requirements, 23 08 00 - Commissioning of HVAC, and 23 09 23 - Building Automation System (BAS) for HVAC.
 1. Upon approval from both the Owner and AE - Submit electronic and four (4) certified copies of Final report to the AE in 3-ring binder manuals, with cover identification. Include index page and indexing tabs. Identify as "Balancing and Testing Report - Approved Final" on Transmittal with relevant numbering as required on Project Submittals.

1.5 REPORT FORMS

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the PSC when needed to supply specified information.
- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify testing points and cross-reference these points to the report forms and procedures.

1.6 QUALITY ASSURANCE

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years of experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.

- B. Work shall be performed in accordance with this Specification, the requirements of the references listed at the start of this section, other identified or related Sections, and Div 1.

1.7 WARRANTY/GUARANTEE

- A. The TAB Contractor shall include an extended warranty of 90-days after Using Agency receipt of a completed balancing report, during which time the Using Agency may request a recheck of terminals, or resetting of outlets, coils, or devices listed in the test report. This warranty shall provide a minimum of 40-man-hours of on-site service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.8 SCHEDULING

- A. Coordinate schedule with other trades. Provide a minimum of seven day notice to the trades prior to performing each test.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Title Page:
 - 1. Project name
 - 2. Project location
 - 3. Project Architect
 - 4. Project Engineer
 - 5. Project General Contractor
 - 6. TAB Company name, address, phone number
 - 7. TAB Supervisor's name and certification number
 - 8. TAB Supervisor's signature and date
 - 9. Report date
- B. Report Index
- C. General Information:
 - 1. Test conditions
 - 2. Nomenclature used throughout report
 - 3. Notable system characteristics/discrepancies from design.
 - 4. Test standards followed
 - 5. Deficiencies noted
 - 6. Quality assurance statement
- D. Instrument List:
 - 1. Instrument
 - 2. Manufacturer, model, and serial number
 - 3. Range

4. Copy of actual NIST level Certificate of Calibration with Calibration date from the manufacturer of the instrument.

2.2 AIR SYSTEMS

A. Duct Leakage Test:

1. Air system and fan
2. Leakage class
3. Test pressure
4. Construction pressure
5. Flow rate (cfm): specified and actual
6. Leakage: Specified and actual.
7. Statement that fire dampers, reheat coils and other accessories were included in the test.
8. Pass or Fail
9. Test performed by
10. Test witnessed by

B. Air Moving Equipment:

1. Drawing symbol
2. Location
3. Manufacturer, model, arrangement, class, discharge
4. Supply flow rate (cfm): specified and actual
5. Return flow rate (cfm): specified and actual
6. Outside flow rate (cfm): specified and actual
7. Exhaust flow rate (cfm): specified and actual
8. Filter pressure drop: specified and actual
9. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
10. Inlet pressure
11. Discharge pressure
12. Fan RPM
13. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier)

C. Fan Data:

1. Drawing symbol
2. Location
3. Manufacturer and model
4. Flow rate (cfm): specified and actual
5. Total static pressure: specified and actual. (Indicate measurement locations).
6. Inlet pressure
7. Discharge pressure

8. Fan RPM
- D. Electric Motors:
1. Drawing symbol of equipment served
 2. Manufacturer, Model, Frame
 3. Nameplate: Horsepower, phase, service factor, RPM, operating amps, efficiency.
 4. Measured: Amps in each phase
- E. Duct Traverse:
1. System zone/branch/location
 2. Duct size
 3. Free area
 4. Velocity: specified and actual
 5. Flow rate (cfm): specified and actual
 6. Duct static pressure
 7. Air temperature
 8. Air correction factor
- F. Air Terminal (Inlet or Outlet):
1. Drawing symbol
 2. Room number/location
 3. Terminal type and size
 4. Velocity: specified and actual
 5. Flow rate (cfm): specified and actual
 6. Percent of design flow rate
- G. Air Terminal Unit (Terminal Air Box) Data:
1. Drawing symbol
 2. Location
 3. Manufacturer and model
 4. Size
 5. Type: constant, variable, single, dual duct
 6. Inlet static pressure during testing (maximum and minimum).
 7. Coil air pressure drop: specified and actual
 8. Cooling maximum flow rate (cfm): specified and actual.
 9. Heating maximum flow rate (cfm): specified and actual.
 10. Minimum flow rate (cfm): specified and actual.
 11. Entering air temperature: specified and actual.
 12. Leaving air temperature (in heating mode): specified and actual.

- H. Air Flow Measuring Station:
 - 1. Drawing symbol
 - 2. Service
 - 3. Location
 - 4. Manufacturer and model
 - 5. Size
 - 6. Flow rate (cfm): specified and actual
 - 7. Pressure drop: specified and actual
- I. Fire, Smoke, and Fire/Smoke Dampers:
 - 1. Damper tag (identification number)
 - 2. System identification
 - 3. Type
 - 4. Size
 - 5. U.L. assembly number
 - 6. Location of damper and access door
 - 7. Fusible link temperature rating
 - 8. Manufacturer and model
 - 9. Operation pass/fail/reset

2.3 HEATING AND PLUMBING SYSTEMS

- A. Pump Data:
 - 1. Drawing symbol
 - 2. Service
 - 3. Manufacturer, size, and model
 - 4. Impeller size: specified, actual, and final (if trimmed)
 - 5. Flow Rate (gpm): specified and actual
 - 6. Pump Head: specified, operating and shut-off
 - 7. Suction Pressure: Operating and shut-off
 - 8. Discharge Pressure: Operating and shut-off
 - 9. Final frequency of motor at maximum flow rate. (On pumps driven by VFD.)
- B. Electric Motors:
 - 1. Drawing symbol of equipment served
 - 2. Manufacturer, Model, Frame
 - 3. Nameplate: Horsepower, phase, service factor, RPM, operating amps, efficiency.
 - 4. Measured: Amps in each phase
- C. Heat Exchangers (as applicable):
 - 1. Drawing symbol

2. Service
 3. Location
 4. Manufacturer and model
 5. Steam pressure in exchanger: specified and actual Flow rate (cfm): specified and actual.
 6. Secondary water entering temperature: specified and actual.
 7. Secondary water leaving temperature: specified and actual.
 8. Secondary water flow: specified and actual.
 9. Secondary water pressure drop: specified and actual.
 10. Secondary water Btuh = (gpm x temperature rise x 500).
- D. AHU Heating Coils:
1. Drawing symbol
 2. Service
 3. Location
 4. Manufacturer and model
 5. Size
 6. Flow rate (cfm): specified and actual
 7. Entering air temperature: specified and actual
 8. Leaving air temperature: specified and actual
 9. Air pressure drop: specified and actual
 10. Steam pressure after valve: specified and actual
 11. Water pressure drop: specified and actual
 12. Entering water temperature: specified and actual
 13. Leaving water temperature: specified and actual
 14. Air Btuh = (cfm x temp rise x 1.09)
 15. Water Btuh = (gpm x temp drop x 500). Repeat tests if not within 10% of air Btuh.
- E. Terminal Heat Transfer Units (Note: Terminal equipment **may** not include balancing valves. Refer to drawings for additional information):
1. Drawing symbol
 2. Location
 3. Manufacturer and model
 4. Flow rate (cfm): specified and actual
 5. Entering air temperature: specified and actual
 6. Leaving air temperature: specified and actual
 7. Include air data only for forced air units

- F. Pipe Systems (Note: includes heating and plumbing branch circuits, balancing valves, pressure regulators, flow controllers, etc. Refer to drawings for additional information):
 - 1. Drawing symbol
 - 2. Service
 - 3. Manufacturer, size, and model
 - 4. Flow Rate (gpm): specified and actual
 - 5. Pressures

2.4 COOLING SYSTEMS

- A. Electric Motors:
 - 1. Drawing symbol of equipment served
 - 2. Manufacturer, Model, Frame
 - 3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency
 - 4. Measured: Amps for each phase
- B. AHU Cooling Coils:
 - 1. Drawing symbol
 - 2. Service
 - 3. Location
 - 4. Size
 - 5. Manufacturer and model
 - 6. Flow rate (cfm): specified and actual
 - 7. Entering air DB temperature: specified and actual
 - 8. Entering air WB temperature: specified and actual
 - 9. Leaving air DB temperature: specified and actual
 - 10. Leaving air WB temperature: specified and actual
 - 11. Air pressure drop: specified and actual
 - 12. Water pressure drop: specified and actual
 - 13. Entering water temperature: specified and actual
 - 14. Leaving water temperature: specified and actual
 - 15. Air Btuh (cfm x enthalpy change x 4.5)
 - 16. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh
- C. Terminal Heat Transfer Units (Note: Terminal equipment does not include balancing valves. Refer to drawing for additional information):
 - 1. Drawing symbol
 - 2. Location
 - 3. Manufacturer and model
 - 4. Flow rate (cfm): specified and actual

5. Entering air DB temperature: specified and actual
6. Leaving air DB temperature: specified and actual
7. Include air data only for forced air units

2.5 ENERGY RECOVERY SYSTEMS

- A. Air Systems - Air energy recovery devices shall be tested at ambient temperatures of less than 40-degrees-F or greater than 85-degrees-F.
 1. Energy Recovery Wheel:
 - a. Drawing Symbol
 - b. Location
 - c. Primary Entering Air Temperature
 - d. Primary Leaving Air Temperature
 - e. Primary Air Pressure Drop
 - f. Primary Air Flow Rate (cfm)
 - g. Secondary Entering Air Temperature
 - h. Secondary Leaving Air Temperature
 - i. Secondary Air Pressure Drop
 - j. Secondary Air Flow Rate (cfm)
 - k. Wheel RPM

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Procedures must conform to a published standard listed in Part 1 of this Section. Equipment shall be adjusted in accordance with the manufacturer's recommendations. Systems not listed in this specification but installed under the Contract Documents shall be balanced using a procedure from a published standard listed in Part 1 of this Section.
- B. Recorded data shall represent actual measured or observed conditions.
- C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- D. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.
- F. The Balancing Contractor shall measure terminal air box air flow, and the BAS Contractor shall adjust DDC readout to match.

3.2 EXAMINATION

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
 1. Equipment is safe to operate and in normal condition.

2. Equipment with moving parts is properly lubricated.
 3. Temperature control systems are complete and operable.
 4. Proper thermal overload protection is in place for electrical equipment.
 5. Filters are clean and in place. If required, install temporary media.
 6. Duct systems are clean and free of debris.
 7. Direction of rotation of fans and pumps is correct.
 8. Fire/smoke and manual volume dampers are in place, functional and open.
 9. Coil fins have been cleaned and combed.
 10. Access doors are closed and end caps are in place.
 11. Air outlets are installed and connected.
 12. Duct system leakage has been minimized.
 13. Hydronic and plumbing systems have been cleaned, filled, and vented.
 14. Strainer screens are clean and in place.
 15. Shut-off, throttling and balancing valves are open.
- B. Report defects or deficiencies to AE.
 - C. Promptly report items that are abnormal or prevent proper balancing.
 - D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
 - E. Beginning of work means acceptance of existing conditions.
 - F. Indicate if flow measuring devices are installed correctly such that accurate measurements can be made.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer. Provide a copy of the actual Certificate of Calibration with Calibration date from the instrument manufacturer with the Plan, Preliminary Report and Final Report.
- C. Prepare a TAB plan that includes strategies and step-by-step procedures.
- D. Complete system-readiness checks and prepare reports. Verify the following:
 1. Permanent electrical-power wiring is complete.
 2. Hydronic and plumbing systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "HVAC Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-

heating, economizer, and other operating modes to determine the maximum required brake horsepower.

- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 3. Re-measure each submain and branch duct after they have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of the terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

- a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - b. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC AND PLUMBING SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5-percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic and plumbing systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open manual valves for maximum flow.
 2. Check liquid level in expansion tank.
 3. Check for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC AND PLUMBING SYSTEMS

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - a. Refer to adjustments section below for pump impeller trim to final duty requirements.
 2. Check system resistance. With the valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10-percent of design.
- B. Measure flow at the automatic flow control valves to verify that valves are functioning as designed.
- C. Measure flow at the pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated pre-settings.
- E. Measure flow at the stations and adjust, where necessary, to obtain first balance.
 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC AND PLUMBING SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR STEAM SYSTEMS

- A. Retain this article if using steam systems.
- B. Measure and record upstream and downstream pressure of each piece of equipment.
- C. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
- D. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- E. Check settings and operation of each safety valve. Record settings.
- F. Verify the operation of each steam trap.

3.11 INSTALLATION TOLERANCES

- A. Adjust supply, return, and exhaust air-handling systems to +10% / -5% of scheduled values.
- B. Adjust outdoor air intakes to within + 5% of scheduled values.
- C. Adjust air inlets and outlets to $\pm 10\%$ of scheduled values.

- D. Adjust supply and exhaust air-handling systems for space pressurization to $\pm 5\%$ of scheduled values, and to provide proper pressurization.
- E. Adjust piping systems to $\pm 10\%$ of design values.

3.12 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.
- B. Once balancing of systems is complete, at least one damper or valve must be 90% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document discrepancies.
- D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.
- E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on pumps not driven by a VFD. Coordinate with contractor.
- F. Participate in commissioning process. Refer to *Section 23 08 00 – Commissioning of HVAC* and Division 1.

3.13 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.
- B. Provide required data and Documentation including but not limited to Submittals of tested equipment components/Systems previously approved by the AE, Schematics and forms per the paragraph entitled "Report Forms" in Part 1 of this section.
- C. Provide BAS Trend Reports, TC "Commissioning Tool" Report or other coincident data capture validating TAB data for flow, pressure, temperature, enthalpy, etc.
- D. Provide overview of findings, calibrations, tolerances, flow and Btuh Capacity balances, rates of same as being on track (part load or design conditions when tested), remaining issues, and delayed balancing and testing scheduled but as yet completed.
- E. Provide Sound and Vibration measurements as defined within referenced Sections and Schedules.

END OF SECTION 230593

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 230713 - DUCT INSULATION

PART I - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Ductwork Insulation
2. Fan and Equipment Insulation
3. Insulation Jackets
4. Insulation Lagging

1.2 DEFINITIONS

A. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.

B. Abbreviations:

1. ALUM: Aluminum
2. ASHRAE: American Society of Heating, Refrigeration, and Air-Conditioning Engineers
3. ASJ: All-service jacket
4. ASTM: The American Society for Testing of Materials.
5. Cu.: Cubic
6. EPDM: Ethylene propylene diene monomer rubber
7. Etc.: Et cetera "and other similar things."
8. F: Degrees Fahrenheit.
9. FMAS: Flexible metallic adhesive system
10. FSK: Foil skim kraft.
11. FT or ' : Feet.
12. HVAC: Heating, Ventilating, and Air-conditioning
13. IECC: International Energy Conservation Code

14. IMC: International Mechanical Code
15. In or “: Inches
16. Lb.: Pounds
17. MICA: Midwest Insulation Contractors Association
18. Mil: A thousandth of an inch
19. NIA : National Commercial and Industrial Insulation Association
20. NBR: Nitrile rubber
21. PVC: Polyvinyl chloride
22. SMACNA: Sheet Metal and Air-conditioning Contractor’s National Association.
23. UIS: The University of Illinois at Springfield.
24. UL: Underwriter’s Laboratories.

1.3 QUALITY ASSURANCE

- A. Installation shall be in compliance with Manufacturer’s recommendations and installation instructions.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Type F: Flexible Fiberglass Wrap, 1.0-lb./cu. ft., ASTM-C553 Type I & II
- B. Type R: Rigid Fiberglass Board, 3.0-lb./cu. ft., ASTM-C612 Type IA
- C. Type L: Flexible Fiberglass Liner (for transfer ducts only); 1.5-lb./cu. ft.
- D. Type P: Rigid Polyisocyanurate Board, ASTM-C591
- E. Type PH: Rigid Phenolic Foam Board, ASTM-C1126 Type III
- B. Type E: EPDM Cellular Flexible Elastomeric Foam Sheet, 300-degrees-F maximum service temperature, ASTM-C534 Grade 1
 1. Basis of Design:
 - a. Aeroflex / Aerocel
 - b. Armacell /
 - (a) AP Armaflex FS
 - (b) UT Solaflex
 3. Disallowed: NBR/PVC blend

2.2 JACKETS, FACTORY APPLIED

- A. ASJ (All Service Jacket): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil vapor barrier backing
- B. FSK (Foil Scrim Kraft jacket): Aluminum-foil vapor barrier, fiberglass-reinforced scrim with kraft-paper backing

2.3 TAPE, ADHESIVES, COATINGS, FASTENERS

- A. Provide in accordance with insulation manufacturer’s specifications and requirements.

- B. Sheet metal screws installed outdoors shall be stainless steel with rubber washers. Use of galvanized screws outdoors not allowed.

2.4 LAGGING, FIELD INSTALLED

- A. ALUM: Aluminum, 0.032" thick, stucco embossed finish
 - 1. For protecting or securing insulation only, not for vapor barrier
- B. FMAS (Flexible Metallic Adhesive System): Self-adhesive embossed aluminum foil sheet, 6.0-mil minimum total thickness.
 - 1. Basis of design:
 - a. VentureClad / 1577CWE

2.5 MATERIAL PROPERTIES

- A. Insulation material shall satisfy material property requirements of referenced ASTM standard. For convenient summary of referenced ASTM standards see *Insulation Specification Materials Guide* as presented by *National Commercial and Industrial Insulation Association (NIA)*.
- B. Duct insulation materials including jackets, tapes, adhesives and coatings shall meet *ASTM-E84 25/50 Flame Spread/Smoke Development* requirements.
- C. Duct insulation located in ventilation air plenums shall be UL listed for application.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General Requirements
 - 2. Install insulation after ductwork has been inspected and tested. Ductwork shall be clean and dry.
 - 3. Completely insulate ductwork conveying air unless specifically indicated otherwise.
 - 4. Insulate components of duct system including but not limited to coil housings and damper frames.
 - 5. Do not apply insulation on cold duct systems, vulnerable to condensation
 - 6. Provide continuity of insulation and vapor barrier through penetrations unless code prohibits. Ensure openings at penetrations adequate in size to accommodate such continuity.
 - 7. Provide continuity of insulation and vapor barrier through hangers and at supports.
 - 8. Provide high compressive strength inserts at supports and hangers, including trapeze hangers, to prevent compression of insulation.
 - 9. Provide protection at each corner of insulated ductwork extending to or through floors or curbs. Construct of sheet metal angle. Extend minimum 12" above floor/curb.
- B. Specific Requirements for Insulation Type
 - 2. Type F - Flexible Fiberglass Wrap
 - a. Mechanically attach at bottom of ducts over 12" wide and completely on the sides of vertical ducts.
 - b. Include the use of staples in attaching adjoining insulation. Cover staples with adhesive tape.
 - 3. Type R - Rigid Fiberglass Board
 - a. Mechanically attach with welded pins and clips.

- 4. Type L - Flexible Duct Liner (for transfer ducts only)
 - a. Mechanically fasten and fully adhere insulation to duct. Attachment with adhesive only is not allowed.
 - b. Butt liner tight without gaps at transverse joints and completely coat edges with adhesive. Coat frayed edges and damaged areas with approved coating.
 - c. Duct dimensions given are net inside dimensions. Ensure that duct size conforms to design dimensions.
 - 5. Type P – Rigid Polyisocyanurate Board
 - a. Mechanically attach. Secure with adhesive as needed.
 - 6. Type PH – Rigid Phenolic Board
 - a. Mechanically attach. Secure with adhesive as needed.
 - 7. Type E – EPDM Cellular Flexible Elastomeric Foam
 - a. Generously adhere insulation to duct or fan. Fully adhere at joints.
- C. Additional Requirements for Outdoor Installations
- 1. Ensure openings in roof and exterior walls adequate in size to accommodate continuity of duct, insulation and vapor barrier.
 - 2. Ensure insulation jacket is sealed waterproof, vapor tight.
 - 3. Provide tightly fitted metal lagging with overlapped sections properly oriented for prevailing winter wind directions.
 - 4. Mechanically attach lagging sections. Seal seams and penetrations watertight.
 - 5. For insulated round duct, attach lagging sections with aluminum or stainless steel bands, 12” on center. Minimize use of screws. Seal seams and penetrations watertight.
 - 6. With approval of PSC: In lieu of metal lagging provide FMAS flexible metallic adhesive system (specification provided above) with factory fabricated aluminum fitting covers. Apply pressure to FMAS with spreading tool to ensure maximum adherence.

3.2 APPLICATION SCHEDULE (Not applicable to laboratory or specialty ductwork)

SERVICE	INSULATION TYPE	JACKET TYPE	LAGGING	MINIMUM THICKNESS*
Outside and Mixed Air Ducts and Plenums, Exposed	R	ASJ	None	2”
Outside and Mixed Air Ducts and Plenums, Concealed	R	FSK	None	2”
Exhaust Air Ducts and Plenums from Damper to Outlet, Exposed	R	ASJ	None	2”
Exhaust Air Ducts and Plenums from Damper to Outlet, Concealed	R	FSK	None	2”
Supply, Return, Relief, and Other Ducts and Plenums, Exposed	R	ASJ	None	1-1/2”

SERVICE	INSULATION TYPE	JACKET TYPE	LAGGING	MINIMUM THICKNESS*
Supply, Return, Relief, and Other Ducts and Plenums, Concealed	F	FSK	None	1-1/2"
Transfer Air Ducts	L	NA	NA	1"
Fans and Equipment Exposed	R	ASJ	None	Same as Duct
Fans and Equipment Concealed	R	FSK	None	Same as Duct
Ducts and Fans in Wet or Humid Indoor Environments	E	None	None	1"
Exterior Ductwork, Plenums and Housings Option 1	P	Integral Moisture Barrier	ALUM or FMAS	2"
Exterior Ductwork, Plenums and Housings Option 2	E	None	ALUM or FMAS	2"
Exterior Ductwork, Plenums and Housings Option 3	R	FSK	ALUM or FMAS	2"

*Notes

1. Manufacturer’s thickness guide or calculation shall be used to determine required minimum insulation thickness for ambient temperature and humidity conditions. Applied insulation thickness shall meet or exceed this value. Thickness may exceed scheduled value.
2. Insulation thickness and R value shall satisfy ASHRAE Standard 90.1 at a minimum.
3. For repairs, insulation thickness shall match existing.

END OF SECTION 230713

This section of the *UIS Facilities Standards* establishes minimum requirements only. It should not be used as a complete specification.

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART I - GENERAL

1.1 SECTION INCLUDES

- A. HVAC Equipment Insulation
- B. HVAC Equipment Insulation Jackets
- C. HVAC Equipment Insulation Finishes
- D. HVAC Equipment Lagging

1.2 QUALITY ASSURANCE

- A. Installation shall be in compliance with Manufacturer's recommendations and installation instructions.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type R: Rigid Fiberglass Board, 3.0 lb./cu. ft., ASTM C612 Type IA
- B. Type E: **EPDM** Cellular Flexible Elastomeric Foam Tube and Sheet, 300 deg. F maximum service temperature, ASTM C534 Grade 1
 - 1. **Not allowed: NBR/PVC blend**
 - 2. Approved Products
 - a. Aeroflex Aerocel
 - b. Armacell
 - (a) AP Armaflex FS
 - (b) UT Solaflex

2.2 JACKETS, FACTORY APPLIED

- A. ASJ: (All Service Jacket): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil vapor barrier backing
- B. FSK: Aluminum-foil vapor barrier, fiberglass-reinforced scrim with kraft-paper backing

2.3 FINISHES, FIELD APPLIED

- A. FM: Woven glass fabric with two coats of mastic approved for insulation type

2.4 TAPES, ADHESIVES, COATINGS, FASTENERS

- A. Provide in accordance with insulation manufacturer's specifications and requirements.
- B. Sheet metal screws installed outdoors shall be stainless steel with rubber washers. Galvanized screws shall not be used outdoors.

2.5 LAGGING, FIELD INSTALLED

- A. ALUM: Aluminum, .016" thick, stucco embossed finish
 - 1. For protecting or securing insulation only, not for vapor barrier
- B. FMAS (Flexible Metallic Adhesive System): Self-adhesive embossed aluminum foil sheet, 6.0 mil minimum total thickness. Basis of design: VentureClad 1577CWE

2.6 REMOVABLE COVERS, CUSTOM MANUFACTURED

- A. Standard Applications, Less than 450 Degrees F.
 - 1. Jacket and liner: 17oz Silicone Impregnated Fiberglass Fabric
 - 2. Insulation: 2" Type E Glass Mat
 - a. 1" allowed for constructability if approved by PSC
 - 3. Fastenings:
 - a. 2" Nomex Velcro and/or Lace Hooks with Braided Kevlar Drawstrings
 - b. Stainless Steel Lace Hooks and Quilt Pins
 - 4. Thread: Kevlar/Stainless Steel Thread
- B. Acoustical Applications, Less than 450 Degrees F.
 - 1. Additionally Provide 2 lb. Mass Loaded Vinyl
- C. Locations: Provide where shown on drawings or otherwise indicated in documents.

2.7 MATERIAL PROPERTIES

- A. Insulation material shall satisfy material property requirements of referenced ASTM standard. For convenient summary of referenced ASTM standards see *Insulation Specification Materials Guide* as presented by *National Commercial and Industrial Insulation Association (NIA)*.
- B. All insulation materials including jackets, tapes, adhesives and coatings shall meet *ASTM E84 25/50 Flame Spread/Smoke Development* requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Requirements.
 - 1. Install insulation after equipment has been inspected and tested.
 - 2. Fit and secure insulation tightly to equipment.
 - 3. Insulate all equipment surfaces not factory insulated and with media design temperature above 105 deg. F, below 60 deg. F or below dew point of ambient air. When fluid is below dew point of ambient air, insulation shall have uninterrupted vapor barrier.
 - a. Exceptions: Steam traps, steam condensate pump bodies, coil headers, CHW components above drain pans (e.g. fan coil units), instrumentation/piping beyond 24" from main.
 - 4. Do not apply insulation on equipment in cold active piping systems.
 - 5. Do not allow insulation to remain unsealed, vulnerable to entrance of moisture.
 - 6. Do not add insulation to factory-insulated surfaces.
 - 7. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.
 - 8. Provide field fabricated removable covers on equipment as required to provide ready access to components requiring periodic maintenance or repair.
 - 9. Provide custom manufactured removable covers as indicated in Application Schedule.
 - 10. Provide sheet metal corner protection angles where insulation extends to floor or is similarly vulnerable to damage.

B. Specific Requirements for Insulation Type

1. Type R - Rigid Fiberglass Board
 - a. Mechanically fasten to equipment
2. Type E - Cellular Flexible Elastomeric Foam
 - a. Form fit insulation tightly to equipment.
 - b. Fully adhere insulation to non-cylindrical equipment (e.g. pumps).
 - c. Generously adhere insulation to cylindrical equipment (e.g. expansion tanks).

C. Additional Requirements for Outdoor Installations.

1. Ensure insulation jacket is sealed waterproof, vapor tight.
2. Provide tightly fitted metal lagging with overlapped sections properly oriented for prevailing weather.
3. Mechanically attach lagging sections. Seal all seams and penetrations watertight.

3.2 APPLICATION SCHEDULE

SERVICE	INSULATION TYPE	JACKET TYPE	LAGGING	FINISH	MINIMUM THICKNESS
Steam to Hot Water Heat Exchanger (Converter) including Head	R	ASJ or FSK	None	FM	3" (as clearance allows)
Steam Condensate Receiver Tank	None	NA	NA	NA	NA
Steam Condensate Pump	None	NA	NA	NA	NA
Steam Expansion Joint - Provide custom manufactured removable cover	Per Spec.	Integral	None	None	2"
Hot Water Pump including Suction Diffuser - Provide custom manufactured removable cover	Per Spec.	Integral	None	None	2"
Hot Water Air/Dirt Separator	R	ASJ or FSK	None	FM	2"
Hot Water Expansion Tank	None	NA	NA	NA	NA
Hot Water Bypass Filter	None	NA	NA	NA	NA
Outdoor Hot Equipment	E or R	E: None R: ASJ or FSK	ALUM or FMAS	None	2" Default

SERVICE	INSULATION TYPE	JACKET TYPE	LAGGING	FINISH	MINIMUM THICKNESS
Chiller Evaporator including Heads/Water Boxes, Compressor Suction Inlet/Piping, Liquid Line, Economizer - Provide field fabricated removable cover on heads/water boxes, economizer	E	None	None	Paint to match equip. color	2"
Chilled Water Pump including Suction Diffuser - Provide field fabricated removable cover on suction diffuser	E	None	None	None	1 1/2"
Double Suction Chilled Water Pump	E	None	None	None	1 1/2"
Chilled Water Air/Dirt Separator	E	None	None	None	1 1/2"
Chilled Water Expansion Tank	E	None	None	None	1"
Chilled Water Bypass Filter - Leave eye bolts exposed	E	None	None	None	1"
Chilled Water Heat Exchanger including Head	E	None	None	None	1 1/2"
Chilled Water Buffer Tank	E	None	None	None	1 1/2"
Cold Outdoor Equipment	E	None	ALUM or FMAS	None	2"

Notes:

1. Provide lagging where required to protect insulation from physical damage.
2. Manufacturer's thickness guide or calculation shall be used to determine required minimum insulation thickness for ambient temperature and humidity conditions. Applied insulation thickness shall meet or exceed this value. Thickness may exceed scheduled value.
3. Insulation thickness and R value shall satisfy ASHRAE Standard 90.1 at a minimum. Insulation thickness may be reduced only as required to accommodate tight clearances and other practical limitations.

For repairs, insulation thickness shall match existing.

END OF SECTION 230716

This section of the *UIS Facilities Standards* establishes minimum requirements only. It should not be used as a complete specification.

SECTION 230719 - HVAC PIPING INSULATION

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Piping and Valve Insulation
- B. Insulation Jackets
- C. Insulation Lagging

1.2 QUALITY ASSURANCE

- A. Installation shall be in compliance with manufacturer's recommendations and installation instructions.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Type F: Fiberglass, Semi-Rigid Premolded, ASTM C547 Type I
- B. Type M1: Mineral Wool, Semi-Rigid Premolded, 1,000 deg. F maximum service temperature, ASTM C547 Type IV
- C. Type M2: Mineral Wool, Semi-Rigid Premolded or Rigid Board, 1,200 deg. F maximum service temperature, ASTM C547 Type II-III
- D. Type C: Calcium Silicate, Rigid Premolded, 1200 deg. F maximum service temperature, ASTM C533
- E. Type E: **EPDM** Cellular Flexible Elastomeric Foam Tube and Sheet, 300 deg. F maximum service temperature, ASTM C534 Grade 1
 - 1. **Not allowed: NBR/PVC blend**
 - 2. Approved Products
 - a. Aeroflex Aerocel
 - b. Armacell
 - (a) AP Armaflex FS
 - (b) UT Solaflex
- F. Type P: Polyisocyanurate, Rigid Premolded, ASTM C591
- G. Type PH: Phenolic, Rigid Premolded ASTM C1126 Type III
- H. Type CG: Cellular Glass, Rigid Premolded, ASTM C552 Type II

2.2 JACKETS, FACTORY APPLIED

- A. ASJ (All Service Jacket): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil vapor barrier backing
- B. PVDC: Polyvinylidene Chloride Film, 60 mil. Basis of design: Saran 560

2.3 JACKETS, FIELD APPLIED

- A. PVC: Polyvinyl Chloride, cut and curled sheet, 30 mil, solvent welded
 - 1. For protecting or securing insulation only, not for vapor barrier
- B. PVDC: Polyvinylidene Chloride Film, 60 mil. Basis of design: Saran 560

- C. FAC: Fiberglass Fabric with Adhesive Coating: 18 oz./sq. yd. fiberglass fabric, lagging adhesive and coating. Basis of design: Foster 81-42
- D. PW: Asphaltic laminate, fiberglass reinforcement with aluminum-foil vapor barrier, 125 mil heat seal. Basis of design: Pittsburgh Corning PITTWRAP

2.4 FITTING COVERS

- A. PVC, standard duty, factory fabricated, 20 mil, tape secured
 - 1. For protecting or securing insulation only, not for vapor barrier
- B. PVC, heavy duty, factory fabricated, 30 mil, solvent welded for use with field applied PVC jacket

2.5 LAGGING, FIELD INSTALLED

ALUM: Aluminum, 016" thick, stucco embossed finish. Fasten with aluminum or stainless steel bands on 12" centers.

- 1. For protecting or securing insulation only, not for vapor barrier
- B. FMAS (Flexible Metallic Adhesive System): Self-adhesive embossed multi-ply aluminum foil sheet, 6.0 mil minimum total thickness. Basis of design: VentureClad 1577CWE

2.6 LAGGING FITTING COVERS

- A. Aluminum, Factory Fabricated, .024" Thick

2.7 REMOVABLE COVERS, CUSTOM MANUFACTURED

- A. Standard Applications, Less than 450 Degrees F.
 - 1. Jacket and Liner: 17oz Silicone Impregnated Fiberglass Fabric
 - 2. Insulation: 2" Type E Glass Mat.
 - a. 1" allowed for constructability if approved by PSC
 - 3. Fastening: 2" Nomex Velcro and/or Lace Hooks with Stainless Steel Wire
 - 4. Thread: Kevlar/Stainless Steel Thread
- B. Acoustical Applications, Less than 450 Degrees F.
 - 1. Jacket: 17oz Silicone Impregnated Fiberglass Fabric
 - 2. Liner: 17oz Teflon Impregnated Fiberglass Fabric
 - 3. Insulation: 2" Type E Glass Mat.
 - 4. Fastening: 2" Nomex Velcro or Lace Hooks with Stainless Steel Wire
 - 5. Thread: Kevlar/Stainless Steel Thread
 - 6. 2 lb. mass loaded vinyl
- C. Provide where shown on drawings or otherwise indicated.

2.8 TAPES, ADHESIVES, COATINGS, FASTENERS

- A. Provide in accordance with insulation manufacturer's specifications and requirements.
- B. Sheet metal screws installed outdoors shall be stainless steel with rubber washers. Galvanized screws shall not be used outdoors.

2.9 MATERIAL PROPERTIES

- A. Insulation material shall satisfy material property requirements of referenced ASTM standards. For convenient summary of referenced ASTM standards see *Insulation Specification Materials Guide* as presented by *National Commercial and Industrial Insulation Association (NIA)*.
- B. All insulation materials including jackets, tapes, adhesives and coatings shall meet *ASTM E84 25/50 Flame Spread/Smoke Development* requirements.
- C. Piping insulation located in ventilation air plenums shall be UL listed for application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Requirements.
 - 1. Install insulation after piping has been inspected and tested unless otherwise authorized by Engineer. Piping shall be clean, dry and free of rust.
 - 2. Insulate all piping systems conveying fluids with temperature above 105 deg. F, below 60 deg. F or below dew point of ambient air. When fluid is below 60 deg. F or below dew point of ambient air insulation shall have uninterrupted vapor barrier.
 - 3. Insulate all components of piping systems for both cold and hot applications. This includes fittings, unions, flanges, strainers, expansion joints and specialties. This includes valve bodies, bonnets, control valves and pressure regulating valves. The common practice of leaving valves, unions, flanges and strainers uninsulated in hot piping systems is not allowed.
 - a. Exceptions: Steam traps, steam condensate pump bodies, coil headers, HW “coil packs”, control valves and balance valves at small terminal heating units (e.g. reheat coils, fin tube,) CHW components above drain pans (e.g. fan coil units), instrumentation and associated piping beyond 24” from main.
 - 4. Do not apply insulation on cold active piping systems, vulnerable to condensation.
 - 5. Do not allow insulation to remain unsealed, vulnerable to entrance of moisture.
 - 6. Provide continuity of insulation and vapor barrier through penetrations unless code prohibits. Ensure openings at penetrations, including roofs and exterior walls, adequate in size to accommodate such continuity.
 - 7. Provide continuity of insulation and vapor barrier through hangers and at supports.
 - 8. Do not use staples or screws to fasten insulation on chilled water or other cold piping.
 - 9. Insulate valves in manner that allows full operation without damaging or compromising insulation or vapor barrier.
 - 10. Install metal shields at all hangers and supports. Shields shall be galvanized sheet metal, half round with flared edges. Length and thickness gauge shall be as follows:

Pipe Size	Shield Size
2” and smaller	12” long x 20 gauge
2 ½” to 6”	12” long x 18 gauge
8” to 14”	18” long x 16 gauge
16” to 24”	24” long x 14 gauge

11. Provide high compressive strength inserts or welded steel shoes at hangers and supports to prevent compression of insulation. Inserts shall be same thickness as insulation. Inserts shall be 180 degree minimum cylindrical segments same length as associated metal shield. Rectangular blocks, plugs, or wood material not acceptable. Inserts and associated jacketing shall be as follows:
 - a. Chilled water applications
 - (1) ≤ 4 " Pipe, metallic and non-metallic
 - (a) Phenolic (2.5 lb./SF) or cellular glass
 - (b) 6 mil PVDC jacket (e.g. Saran 560)
 - (2) ≥ 6 " Pipe, metallic and non-metallic
 - (a) Phenolic (5.0 lb./SF) or cellular glass
 - (b) 6 mil. PVDC jacket (e.g. Saran 560)
 - b. Hot water applications
 - (1) ≤ 4 " Pipe, metallic and non-metallic
 - (a) Phenolic (2.5 lb./SF) or calcium silicate
 - (b) ASJ or 6 mil. PVDC jacket (e.g. Saran 560)
 - (2) ≥ 6 " Pipe, metallic
 - (a) Welded shoe with insulation fill
(See Section 23 05 29 – Hangers and Supports for HVAC)
 - (b) ASJ jacket
 - (3) ≥ 6 " Pipe, non-metallic (e.g. polypropylene)
 - (a) Phenolic (5.0 lb./SF) or cellular glass
6 mil. PVDC jacket (e.g. Saran 560)
 - c. Steam applications
 - (1) ≤ 4 " Pipe, metallic
 - (a) Calcium silicate
 - (b) ASJ jacket
 - (2) ≥ 6 " Pipe, metallic
 - (a) Welded shoe with insulation fill
(See Section 23 05 29 – Hangers and Supports for HVAC)
 - (b) ASJ jacket
12. Provide high compressive strength inserts at strut-mount pipe clamps to prevent compression of insulation. Inserts shall be phenolic or calcium silicate as appropriate for application. Inserts shall be same thickness as insulation. Insert shall be 360 degree cylindrical segment extending beyond pipe clamp on each side. 180 degree cylindrical shields shall be provided. "Cush-clamps" (e.g. *Unistrut Cush-a-Clamp*) not allowed unless approved by PSC for specific application. In no case shall such be used on cold piping applications.
13. As an alternate to specified support system for strut-mount pipe clamps *Aeroflex Aerofix-U* polymeric inserts with integral vapor barrier may be used. Such applies to strut-mount clamps only.

14. As an alternate to specified support system, Hydra-Zorb Klo-Shure insulation coupling may be used. Insulation shall be adhered within coupling to maintain vapor barrier.
 15. Ensure piping is supported by specified inserts only. Piping shall not be in direct contact with metallic hangers/supports. Exception: Welded shoe pipe supports on hot piping applications.
 16. Provide heavy duty protective lagging on insulated piping extending to or through floors or curbs. Lagging shall be .032" thick aluminum sheet, mechanically secured. Extend minimum 12" above floor/curb.
 17. Provide protective 30 mil solvent-welded PVC jacket on exposed interior horizontal piping below 2' AFF level and exposed vertical piping below 8' AFF level. Also provide 30 mil solvent-welded PVC jacket on any horizontal piping above 2' AFF that is vulnerable to damage by climbing or stepping. Example: Branch run-outs to coils.
 - a. Exception: In cases where temperature rating of PVC jacket is deemed inadequate for high temperature application, .024" thick aluminum lagging with safety break shall be provided.
- B. Specific Requirements for Insulation Type
1. Type F: Fiberglass, Semi-Rigid Premolded
 - a. Insulate fittings with field or factory cut fiberglass inserts, multiple inserts may be required. Install PVC fitting covers over insulation. Fasten fitting covers to pipe jacket with PVC tape, both ends. Tacks or staples not allowed.
 2. Type M1: Mineral Wool, Semi-Rigid Premolded
 - a. Insulate fittings with field or factory cut fiberglass inserts, multiple inserts may be required. Install 20 mil PVC fitting covers over insulation. Fasten fitting covers to pipe jacket with PVC tape, both ends. Tacks or staples not allowed.
 3. Type M2: Mineral Wool, Semi-Rigid Premolded
 - a. Insulate fittings with like material, factory or field fabricated. Flexible inserts not allowed. Install aluminum lagging.
 4. Type CS: Calcium Silicate; Rigid Premolded
 - a. Attach with 18 gage SS tie wires on 12" centers
 - b. Use single layer for less than 3" thick. For thickness 3" and greater, use two layers, stagger jointed. Wire each layer individually.
 - c. Install lagging as indicated in *Application Schedule* below.
 5. Type E: **EPDM** Elastomeric Foam, Flexible Tube and Sheet
 - a. Fully adhere insulation to pipe at joints and terminations to prevent moisture transfer along pipe. Adhere around entire circumference of pipe.
 - b. Form fit and fully adhere insulation at valves, strainers, specialties, instrumentation and appurtenances. Fully adhere insulation at all points vulnerable to ingress of moisture.
 6. Type P: Polyisocyanurate, Rigid Premolded
 - a. Use fittings of like material, factory or field fabricated.
 - b. Place vapor barrier over fitting; install finished fitting cover (i.e. tape fitting before installing cover).
 - c. Fill any voids in insulation that result from custom fit-up.

- d. Seal all openings in Saran vapor barrier with approved mastic.
 - 7. Type PH: Phenolic, Rigid Premolded.
 - a. Use fittings of like material, factory or field fabricated.
 - b. Place vapor barrier over fitting; install finished fitting cover (i.e. tape fitting before installing cover).
 - c. Fill any voids in insulation that result from custom fit-up.
 - d. Seal all openings in Saran vapor barrier with approved mastic.
 - 8. Type CG: Cellular Glass, Rigid Premolded.
 - a. Install above ground CG insulation with ASJ jacket and vapor barrier mastic.
 - b. Install buried CG insulation with PW jacket per manufacturer's instructions to maintain warranty. Install to adequately accommodate pipe movement. Provide joint sealant (e.g. Pittsburgh Corning PITTCOTE) at joints, changes in insulation thickness and terminations.
- C. Additional Requirements for Outdoor Installations
- 1. Ensure insulation jacket is sealed waterproof, vapor tight.
 - 2. Provide tightly fitted metal lagging with overlapped sections properly oriented for prevailing weather.
 - 3. Mechanically attach lagging sections with aluminum or stainless steel bands, 12" on center. Minimize use of screws. Seal all seams and penetrations watertight.

3.2 APPLICATION SCHEDULE

Application	Insulation	Thickness Ref.# (see Thickness Schedule)	Jacket, Covering	Lagging
Steam, Condensate and Pumped Condensate in Building	F or M1	(1) Steam (2) Cond.	ASJ where concealed; PVC where exposed	None*
Steam Vent Above 8' AFF level	None	NA	NA	NA
Steam Vent Below 8' AFF level (for burn protection)	F or M1	1" All Pipe Sizes	ASJ where concealed; PVC where exposed	None*
Perimeter, Preheat, Reheat Water > 140F	F or M1	(3)	ASJ where concealed; PVC where exposed	None*
Perimeter, Preheat, Reheat Water < 140F	F or M1	(4)	ASJ where concealed; PVC where exposed	None*

Application	Insulation	Thickness Ref.# (see Thickness Schedule)	Jacket, Covering	Lagging
Chilled Water	E or PH	(6)	E: None PH: PVDC	None*
Chilled Beam	E	(6)	None	None*
Cooling Coil Condensate Drain	E	(7)	None	None*
Piping with Temperature 60F–105F (e.g. Chilled Beam, Condenser Water)	None	NA	NA	NA
Piping with Temperature 0-40F (e.g. Refrigerant for Walk-In Cooler/Freezer)	E or PH	(8)	E: None PH: PVDC	None*
Chilled Water, Buried (Ductile Iron)	None	NA	NA	NA
Other Buried Piping, Not Preinsulated	CG	(1)	PW	None
Cold Piping Outdoors, Above Ground Option 1	P or E	(6)	E: None P: PVDC	ALUM or FMAS
Cold Piping Outdoors, Above Ground Option 2	CG	(6)	ASJ	ALUM or FMAS*
Hot Piping Outdoors, Above Ground Option 1	M1	(2)	ASJ	ALUM or FMAS*
Hot Piping Outdoors, Above Ground Option 2	CG	(2)	ASJ	ALUM or FMAS*

* Provide lagging in areas specified for protection from physical damage.

3.3 THICKNESS SCHEDULE

Application Schedule Reference#	Temp Reference	Minimum Insulation Thickness for Pipe Size					
		3/4" & Smaller	1 - 1 1/4"	1 1/2 - 2"	2 1/2 - 3"	4 - 6"	8" & Larger
(1)	250-350F	3.5	4.0	4.5	4.5	4.5	4.5
(2)	200-250F	2.5	2.5	3.0	3.0	3.0	3.0
(3)	140-200F	1.5	1.5	2.0	2.0	2.0	2.0
(4)	105-140F	1.0	1.0	1.5	1.5	1.5	1.5
(5)	60-105F	NA	NA	NA	NA	NA	NA
(6)	40-60F	1.0	1.0	1.5	1.5	1.5	2.0
(7)	40-60F	0.5	0.5	0.5	0.5	0.5	0.5
(8)	<40F	1.0	1.0	1.5	1.5	1.5	2.0

Notes:

1. Manufacturer's thickness guide or calculation shall be used to determine required minimum insulation thickness for ambient temperature and humidity conditions. Applied insulation thickness shall meet or exceed this value. Thickness may exceed scheduled value.
2. Insulation thickness and R value shall satisfy ASHRAE Standard 90.1 at a minimum.
3. For repairs, insulation thickness shall match existing.

END OF SECTION 230719

This section of the *UIS Facilities Standards* establishes minimum requirements only. It should not be used as a complete specification.

SECTION 230800 - COMMISSIONING OF HVAC

PART I - GENERAL

1.1 SUMMARY

- A. Commissioning shall be done in accordance with ASHRAE-90.1, 6.7.2.4. System Commissioning.

1.2 DEFINITIONS

A. Abbreviations:

1. AABC: The Associated Air Balance Council
2. AHU: Air-handling unit
3. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
4. BAS: Building Automation System.
5. CM: Construction Manager
6. CxA: Commissioning Authority
7. DB: Dry bulb temperature.
8. DP: Differential pressure
9. E.g.: Exempli gratia "for example"
10. Etc.: Et cetera "and other similar things"
11. GC: General Contractor
12. HVAC: Heating, Ventilating, and Air-conditioning
13. I/O: Input / output
14. LEED: Leadership in Energy and Environmental Design
15. NEBB: National Environmental Balancing Bureau
16. O&M: Operation and maintenance
17. OSA: Outside air
18. SAT: Supply air temperature
19. TAB: Testing, adjusting, and balancing
20. Temp – Temperature
21. UIS: The University of Illinois at Springfield
22. USGBC: United States Green Building Council

1.3 HEATING, VENTILATING, BUILDING AUTOMATION SYSTEMS (BAS), AND TAB WORK

- A. The commissioning tasks applicable to the mechanical, BAS and TAB work of Division 23 are as follows (references apply to equipment to be commissioned only):
1. Construction and Acceptance Phase Requirements
 - a. Submittal data, commissioning documentation, O&M data and training.
 - b. Attend each and every commissioning meeting.
 - c. Provide shop drawings of equipment to be commissioned along with completed & signed Pre-Functional checklists.

- d. Document start-up and functional testing procedures including.
 - 1) Manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, Owner-contracted tests, fan and pump curves, factory testing reports, and warranty information.
 - 2) The Owner will require additional documentation necessary for LEED submittals if required by USGBC.
 - e. Table of Contents with listing of equipment that will be included in the O&M manuals for review and approval.
 - f. Specific functional performance test procedures.
 - g. Alarm limits to be used during the tests.
 - h. Start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists for equipment to be commissioned. Submit to AE for review and approval prior to startup. Refer to *Section 01 91 13* for further details on start-up plan.
 - i. Prior to startup and initial checkout process, execute the mechanical prefunctional checklists for equipment to be commissioned.
 - j. Perform and clearly document system operational checkout procedures and completed startup, promptly providing a copy to the Owner as components are completed and systems are debugged and completed.
 - k. Correct each and every punch list items before functional testing.
 - l. Air and water TAB shall be completed with discrepancies and problems remedied before requesting Owner witnessing functional testing.
 - m. Functional Performance Tests / Procedures may be used to perform adjustments prior to witnessing by the AE and Owner.
 - n. Complete functional performance testing for specified equipment in Section 01 91 13. Assist the Owner in interpreting the monitoring data.
 - o. Correct deficiencies as interpreted by the AE and retest the equipment prior to Functional Performance Witnessing by the CxA. Coordinate scheduling of Functional Performance Witnessing with the AE and Owner.
 - p. Provide Documentation, Plans, Reports, Notes, Output from Electronic Commissioning Tools / other analysis tools to the Owner promptly upon successful Functional Test witnessing.
 - q. Update O&M manuals according to the Contract Documents.
 - r. Provide training of the Owner's operating staff.
 - s. Document specific requirements to maintain the validity of the warranty.
2. Warranty Period
- a. Execute seasonal or deferred functional performance testing, witnessed by the Owner.
 - b. Correct deficiencies and make adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.4 HEATING AND VENTILATING WORK

- A. Provide startup for HVAC equipment, except for the BAS system.
- B. Assist and cooperate with the TAB contractor and Owner by:
 - 1. Include HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning.

2. Include sheaves and belts that may be required by TAB.
 3. Provide test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Provide an approved plug.
 4. Provide temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
- C. Prepare a preliminary schedule for Division 23 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the Owner. Update the schedule.
- D. Notify the Owner depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the Owner, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the Owner has the scheduling information needed to efficiently execute the commissioning process.

1.5 BAS WORK

- A. Sequences of Operation Submittals. The BAS submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
1. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
 2. Interactions and interlocks with other systems.
 3. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 4. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
 5. Start-up sequences.
 6. Warm-up mode sequences.
 7. Normal operating mode sequences.
 8. Unoccupied mode sequences.
 9. Shutdown sequences.
 10. Capacity control sequences and equipment staging.
 11. Temperature and pressure control: setbacks, setups, resets, etc.
 12. Detailed sequences for control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 13. Effects of power or equipment failure with standby component functions.
 14. Sequences for alarms and emergency shut downs.
 15. Seasonal operational differences and recommendations.
 16. Initial and operational values for adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc., that will be useful during testing and operating the equipment.
 17. Schedules, if known.

18. To facilitate referencing in testing procedures, sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.
 19. Prior to Functional Performance Witnessing by the Owner, correct deficiencies as may be interpreted by the AE and retest the equipment. Coordinate and confirm scheduling of Functional Performance Witnessing with the Owner providing a pdf of successful trending as indication systems are ready for this procedural test phase.
 20. Promptly provide Documentation, Plans, Reports, Notes, Output from Electronic Commissioning Tools / other analysis tools to the Owner.
- B. Control Drawings Submittal
1. The control drawings shall have a key to each and every abbreviations.
 2. The control drawings shall contain graphic schematic depictions of the systems and each component.
 3. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 4. Provide a full points list with at least the following included for each point:
 - a. Controlled system
 - b. Point abbreviation
 - c. Point description
 - d. Display unit
 - e. Control point or setpoint
 - f. Monitoring point
 - g. Intermediate point
 - h. Calculated point
 - i. Point Description: DB temp, airflow, etc.
 - 1) Control or Setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
 - 2) Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
 - 3) Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
 - 4) Calculated Point: "Virtual" point generated from calculations of other point values.
 - j. The Contractor shall keep the Owner informed of changes to this list during programming and setup.
- C. The Contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing, including:
1. System name.
 2. List of devices.
 3. Procedures for testing each controller after installation.

4. A blank copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has “passed” and is operating within the contract parameters.
 5. A description of the instrumentation, if any, required for testing.
 6. Identify what tests on what systems must be completed for TAB work. Coordinate with the Owner and TAB contractor for this determination.
- D. Assist the TAB contractor in the following manner:
1. Review the TAB plan to determine the capabilities of the building automation system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).
 2. For a given area, have required prefunctional checklists, calibrations, startup and selected functional tests of the system debugged, completed then approved by the Owner prior to TAB.
 3. Provide a qualified technician to operate the controls during TAB, or provide sufficient training for TAB to operate the system without assistance.
 4. Provide an points report (digital) validating commands and responses with calibrated data matching and validating the required data / Report from the TAB.
- E. Provide a signed and dated certification to the Owner upon completion of the checkout for controlled devices, equipment and systems prior to functional testing for each piece of equipment or system, that system programming is complete as to each and every respect of the Contract Documents, except functional testing requirements.
- F. Assist and cooperate with the Owner in the following manner:
- G. In addition to the control points necessary to execute control sequences, provide monitoring, control and virtual points as required in the Contract Documents.
- H. Prior to Functional Performance Witnessing by the Owner, correct deficiencies as may be interpreted by the AE and retest the equipment. Coordinate and confirm scheduling of Functional Performance Witnessing with the Owner.
- I. Promptly provide Documentation, Reports, Notes, Output from Electronic Commissioning Tools / other analysis tools to the Owner.
- J. List and clearly identify on the as-built duct and piping drawings, the locations of static and differential pressure sensors (air, water and building pressure).
- K. An updated as-built version of the control drawings and sequences of operation shall be included in the final BAS O&M manual submittal.
- 1.6 TAB WORK.
- A. Prior to starting TAB, submit the qualifications of the site technician for the project, including the name and contact information of the contractors and facility managers of recent projects the technician on which was lead. The Owner shall approve the site technician’s qualifications for this project.
 - B. A running log of events and issues shall be kept by the TAB field technicians. Discrepancies, deficiencies or uncompleted work by others, contract interpretation requests and lists of completed tests shall be provided to the Owner prior to Witness Phase of Functional Testing.
 - C. Communicate in writing or during recorded meetings with the Owner setpoint and parameter changes made or problems and discrepancies identified during TAB that affect the control system setup and operation.

- D. Provide a Preliminary TAB report within two weeks of completion. A copy will be provided to the Owner. The report will contain a summary explanation of the assumptions and the results in a clear format with designations of uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC or NEBB.
- E. Provide the Owner with any requested data, gathered in accordance with the Project, but not shown on the draft reports as necessary to satisfy USGBC reporting.
- F. Conduct spot checks on performed balancing for witness by the Owner.
- G. Provide a final electronic TAB report organized in accordance with Project requirements with details. Include documentation previously identified and / or requested.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 STARTUP

- A. The Heating, Ventilating and BAS Work shall clarify start-up responsibility and requirements to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Owner.
- B. Work shall identify responsibility for calibrating control sensors and equipment.

3.2 CONTRACTOR TESTS

- A. Contractors shall forward to the Owner a list and schedule of specified contractor tests. The tests shall include at least the following:

Hydronic Piping	Hydrostatic Testing Cleaning
Steam and Condensate Piping	Testing Cleaning
Ductwork	Ductwork Testing
Custom AHUs	Startup Pressure Testing
Dedicated Outside Air Unit	Startup Pressure Testing
Controls	Preparation (calibration)

- B. Unless specified otherwise, provide a minimum one week prior notice to the Owner for each specified Contractors' test.
- C. Submit Contractors' test reports to the Owner within one week of the successful completion of each test. Contractors shall document and issue a test report for each required test. Individual test reports should be bundled together into a group for submission to the Owner. The test report shall contain comprehensive information required by the respective specification section including the test date, start time, stop time, test duration, initial values, final values, expected result, and acceptable test values (per individual specification sections). The person(s) conducting each test

and the local code authority (if applicable) shall sign and date each test report indicating that the test has been successfully completed and the results are within acceptable parameters.

3.3 FUNCTIONAL PERFORMANCE (WITNESSED) TESTS

- A. Checkouts, coordination with other Contractors, Work, debugging, preliminary reports including validating coordinated work with BAS, Vent and Heating Contractors shall have been completed prior to requesting scheduling of Owner witnessing of Functional Testing Procedures.

3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

3.5 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications. Refer to *Section 01 78 23 – Operation and Maintenance Data* and *Section 01 91 13 – General Commissioning Requirements* for additional O&M manual requirements.
- B. Additional BAS O&M Manual Requirements. In addition to documentation that may be specified elsewhere, the BAS Contractor shall compile and organize at minimum the following data on the control system in labeled three-ring binders with indexed tabs.
 - 1. Three copies of the controls training manuals.
 - 2. The O&M manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:
 - a. Sequences of operation
 - b. Control drawings
 - c. Points lists
 - d. Controller/module data
 - e. Thermostats and timers
 - f. Sensors and DP switches
 - g. Valves and valve actuators
 - h. Dampers and damper actuators
 - i. Program setups (software program printouts)
 - 3. Operation and Maintenance Manuals content:
 - a. Specific instructions on how to perform and apply functions, features, modes, etc., mentioned in the controls training sections of this specification and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.
 - b. Full as-built set of control drawings (refer to Submittal section above for details).
 - c. Full as-built sequence of operations for each piece of equipment.
 - d. Full points list.
 - e. Full print out of schedules and set points after testing and acceptance of the system.
 - f. Full as-built print out of software program.
 - g. Electronic copy on disk of the entire program for this facility.
 - h. Marking of system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

- i. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 - j. Control equipment component submittals, parts lists, etc.
 - k. Warranty requirements.
 - l. Copies of checkout tests and calibrations performed by the Contractor (not commissioning tests).
4. Field checkout sheets shall be provided to the Owner for inclusion in the Commissioning Record Book (merged with Systems Manual).
- C. Review and Approvals. Review of the commissioning related sections of the O&M manuals shall be made by the Owner. Refer to *Section 01 91 13*.

3.6 DEFERRED TESTING

- A. Refer to Section 01 91 13 for requirements of deferred testing.

3.7 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors will consist of the start-up and initial checkout plan, other Plans, Contractor Tests, the filled out Start-up, Checkouts such as but not limited to Pre-Functional Checklists, BAS and TAB (trend proofs, I/O value reports logs), Preliminary TAB and Final TAB Reports described herein and in *Section 01 91 13*.

END OF SECTION 230800

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Electronic Sensors, Switches, Relays, and Indicating Devices
- B. Pneumatic Sensors, Switches, Relays, and Gauges
- C. Control Valves
- D. Automatic Dampers
- E. Flow Meters

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Control Valves
- B. Flow Switches
- C. Flow Meters
- D. Thermowells
- E. Pressure Gauge Taps
- F. Automatic Dampers

1.3 SYSTEM DESCRIPTION

- A. Provide control system components consisting of thermostats, temperature sensors, pressure sensors, relays, control valves, dampers and operators, indicating devices, and other apparatus and accessories required to operate mechanical systems and perform functions specified.
- B. Provide guidance for selection and sizing of control valves and dampers. Selections shall be based on actual system design parameters with no "rule of thumb" methods of selection. Building Automation Systems (BAS) Contractor is responsible for the selection of valves, dampers, and actuators.
- C. Provide materials and labor necessary to connect factory-supplied control components to existing control systems.
- D. Unless specified otherwise, provide fully proportional components.
- E. Provide power supplies and interconnecting wire and conduit.

1.4 SUBMITTALS

- A. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. *Section 01 33 23 – Shop Drawings, Project Data, and Samples*
 - 2. *Section 01 77 00 – Closeout Procedures*
 - 3. *Section 01 78 23 – Operation and Maintenance Data*
- B. In addition, comply with the following specific requirements:
 - 1. Provide damper and actuator shop drawings showing unique tag numbers for each device, equipment or system served, device model numbers, duct sizes, damper sizes, flow rates, velocities, calculated pressure drops, leakage rates, torque requirements, actuator model number, actuator torque capacities, and pilot positioner locations.

2. Select dampers to meet their intended service with respect to maximum approach velocities and maximum pressure differential.
3. Submit valve schedule shop drawing which indicates unique tag numbers for each device, equipment or system served, device model numbers, sizes, shutoff head, actuator, required air pressure, torque requirements for rotary valves, flow coefficients (Cv) for 10 percent and 100 percent travel, design flow, pressure drop calculations, actuator model number, actuator torque capacities, and pilot positioner locations.
4. Provide complete operating data, system drawings, wiring diagrams, and written detailed descriptions of sequences. One copy of the as-built control diagram shall be placed inside each control panel. Provide pocket inside the door. Another copy of the as-built control diagram shall be placed in the O&M manual.
5. Operation and Maintenance manuals shall be organized by specification number and shall have a table of contents and tabs for each piece of equipment or system. In addition to requirements listed in *Section 01 78 23 - Operation and Maintenance Data*, Operation and Maintenance manuals shall also include:
 - a. Copies of all shop drawings in both paper and electronic format. Electronic drawings shall be provided on CD-ROM in the AutoCAD format listed in *Section 01 78 39 – Project Record Documents* of these Standards.
 - b. Manufacturer's operation and maintenance instructions. Include parts lists of all items or equipment with exploded view of components with part numbers. Designate the specific model when several options are shown. Include CD-ROM if available.
 - c. Product data sheets, engineering data and manufacturer's installation instructions on each control system component. Include sizing criteria and calculations.
 - d. Contact information on local parts suppliers and service companies.
 - e. Composite Electrical Diagrams.
 - f. Actual location of control components, including panels, thermostats, and sensors. Include revised shop drawings to reflect actual installation and operating sequences.
 - g. Factory and field calibration and commissioning records.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years' experience.
- B. Installer: Company specializing in applying the work of this section with minimum three years' experience. Installers must be factory certified by the control system manufacturer.
- C. BAS Contractors are limited to firms regularly employing a minimum of 5 full time service people within 100 miles of the job site.

1.6 WARRANTY

- A. General: Provide one-year warranty on all materials and labor upon substantial completion.
- B. Flow Meters: Each flow meter assembly shall carry a performance warranty of at least two years from the date of installation and startup. This warranty shall cover parts and labor for repair or replacement of the meter assembly. Performance during the warranty period shall satisfy the requirements listed in Part 2 – Products of this specification for accuracy and repeatability.

PART 2 - PRODUCTS

2.1 ELECTRONIC SENSORS, SWITCHES, RELAYS AND INDICATING DEVICES

A. Temperature Sensors

1. General

- a. Sensors shall be 1000 ohm Platinum RTDs with the following minimum performance:
 - (1) Temperature Coefficient of Resistivity (TCR) of .00385 ohm/ohm/°C for platinum RTD's.
 - (2) Accuracy of $\pm 0.1\%$ at 32 degrees F (Class B) for platinum RTDs.
 - (3) Operating range of 0 to 99% Relative Humidity non-condensing.
- b. Thermistors are acceptable in VAV box applications downstream of reheat coils and where it's the manufacturer's only native option.
- c. Thermocouples with transmitters or pneumatic sensors with transmitters are not acceptable.

2. Immersion Sensors

- a. RTD must be installed within a 316 stainless steel thermowell using a non-hardening heat conducting paste.
- b. Thermowell shall be machined from a solid piece of 316 stainless steel bar stock. Thermowell shall be rated for a minimum static pressure of 500 psig at the maximum operating temperature and be capable of withstanding water velocities of up to 27 fps.
- c. The sensor shall be mounted so that it extends into the flow stream to a minimum of 1/3 of the diameter of the pipe. For pipes greater than 10 inch diameter, thermowell shall be installed in a position 45 degrees from the bottom of the pipe.
- d. ACI 1K-2w-i-(length)-gd-316 SST or equivalent

3. Duct Mounted Sensors

- a. For averaging service, provide 1000 ohm RTD sensing element. Sensing element shall have a minimum of 1 foot of sensor length for each 2 square feet of duct or coil area. Sensor shall be arranged evenly across the duct or coil such that no point in the duct or coil is more than 1 foot away from the sensor.
- b. Install stainless steel flanges where elements penetrate ducts. Support elements with appropriate clips on coil faces, or 1/2" conduit in open ducts and plenums.
- c. See related drawing detail.

4. Space Temperature Sensors and Thermostats

- a. Electronic thermostats shall be used in conjunction with DDC VAV controllers. Pneumatic thermostats shall be used in all other locations.
- b. Each thermostat in an office, classroom, lecture hall, laboratory, or other nonpublic area shall incorporate an accessible setpoint adjustment feature.
- c. Each thermostat in a corridor, lobby, atrium, stairwell, lounge, restroom or other public area shall incorporate a blank cover with no adjustment feature.
- d. Each thermostat must digitally display the current setpoint and temperature.
- e. Each thermostat must have an active communications port to allow access to the controller from a laptop computer.

5. Outdoor Air Temperature shall be a 1000 Ohm Platinum RTD sensor, preferably located on the north side of the building and shaded with sun shield. Sensor shall be located at least six

feet above grade away from window wells and exhaust openings. (ACI 1K-2w-o-sun or equivalent)

6. Freeze Protection Stats

- a. Sensing elements shall have a minimum of 1 foot of sensor length for each 1 square foot of duct or coil area. The element shall be of the vapor tension type, such that any 18" section along the entire length of measuring element is capable of triggering the switch. Sensor shall be arranged evenly across the duct or coil such that no point in the duct or coil is more than 6" away from the sensor.
- b. For protection of cooling coils, locate sensing element on the upstream face of the cooling coil.
- c. For protection of preheat coils with horizontal tubes, locate sensing element on the downstream side of the preheat coil making sure that the bottom horizontal run of the sensing element is at the same elevation as the bottom row of the steam coil. If there are multiple steam coils that are stacked and trapped separately, make sure the sensing element protects the bottom row of all coils. Preheat coils with vertical tubes require special consideration.
- d. Furnish each thermostat with one single pole, single throw normally opened switch and one single pole, single throw normally closed auxiliary switch.
- e. Setpoint range shall be 15 degrees F to 55 degrees F with a permanent stop set at 35 degrees F.
 - (1) Differential shall be fixed at approximately 5 degrees F, and supplied with manual reset.
- f. Setpoint range shall be 15 degrees F to 55 degrees F with a permanent stop set at 40 degrees F.
 - (1) Differential shall be fixed at approximately 5 degrees F, and supplied with automatic reset.
- g. Low Temperature T'Stat, - 35 deg. F manual reset freeze stat [Siemens 134-1504 or ACI/FS-2 (20')]
- h. Low Temperature T'Stat, - 40 deg. F Auto reset freeze stat [Johnson Controls A70GA-1 or ACI/FS-2A (up to 50')]
- i. For a corrosive environment, substitute a Minco Chill-Out Combination Sensor. For an aquatic facility, use an aluminum element.
- j. See related drawing detail.

B. Pressure Instruments

1. General

- a. Select device suitable for intended application; water, steam, or air, static or differential.
- b. Select for appropriate range, including negative if applicable. Must be able to withstand all pressures expected in installed location without need for recalibration.
- c. Pressure transmitter shall be a loop-powered device.
- d. Pressure transmitter shall have zero and span adjustments on the device.

2. Static Pressure Instruments

a. Hydronic

- (1) 100 percent solid state device, temperature compensated, suitable for pressures of 200 percent rated range with averaging to stabilize output, accuracy of ± 0.25 percent, and a 4-20 mA output.
- (2) SETRA Model 256

b. Air

- (1) 100 percent solid state device, temperature compensated, suitable for pressures of 200 percent rated range with averaging to stabilize output, accuracy of ± 1 percent, and a 4-20 mA output.
- (2) For duct-mounted application, install a manufactured static sensing probe per manufacturer's recommendations.
- (3) SETRA Model MRG with display, ACI DLP for low pressure application.
- (4) SETRA Model MRG for high pressure application.
- (5) SETRA Model 269 low Differential pressure transducer for control and monitoring in laboratories, and other critical environments.

c. Steam

- (1) Shall be installed with impulse piping "pigtail", which must be filled with water before startup to prevent damage. These transmitters shall be installed on the pipe rack, below the steam pipe, away from dissipated steam heat.
- (2) Rosemount 3051T, YOKAGAWA **EJA530E**, Foxboro IGP10 with the following options:
 - (i) Gauge pressure
 - (ii) $\frac{1}{2}$ " – 14 NPT female process connection
 - (iii) Silicone fill fluid
 - (iv) Wetted parts material shall be 316L SST
 - (v) Aluminum housing
 - (vi) Local display
 - (vii) Digital HART communication protocol and 4-20mA output
 - (viii) $\frac{1}{2}$ " NPT conduit connection

3. Differential Pressure Instruments

a. Hydronic

- (1) Yokogawa **EJA110E**, Foxboro IDP10, Rosemount 3051CD
 - (i) $\frac{1}{2}$ " – 14 NPT female process connection
 - (ii) Silicone fill fluid
 - (iii) Wetted parts material shall be 316L SST
 - (iv) Aluminum housing
 - (v) Local display
 - (vi) Digital HART communication protocol and 4-20mA output

(vii) ½" NPT conduit connection

(viii) Mounting bracket kit

b. Air

(1) 100 percent solid state device, temperature compensated, suitable for pressures of 200 percent rated range with averaging to stabilize output, accuracy of ±1 percent, and a 4-20 mA output.

(2) SETRA Model MRG series with display or ACI Model: A/DLP-001-W-U-D-A-3 Range: 0-1 in WC, A/DLP-010-W-U-D-A-3 Range: 0-10 in WC

a. BAS Contractor shall provide transmitter for each filter bank.

(3) The static sensor tip shall be a minimum of 3 inches from the inside wall of the duct.

c. Steam (as applied to DP type flow measuring devices)

(1) Shall be installed remotely, with device lower than the tap from the supply line. Impulse piping must be filled with water before startup to prevent damage. Impulse piping must be long enough to protect the transducer from excessive temperatures.

(2) 100 percent solid state device, temperature compensated, suitable for pressures of 200 percent rated range with averaging to stabilize output, accuracy of ±0.25 percent, and a 4-20 mA output.

(3) Device shall be provided with HART communication protocol.

(4) Yokogawa **EJA110E**, Foxboro IDP10, Rosemount 3051CD

(i) ½" – 14 NPT female process connection

(ii) Silicone fill fluid

(iii) Wetted parts material shall be 316L SST

(iv) Aluminum housing

(v) Local display

(vi) Digital HART communication protocol and 4-20mA output

(vii) ½" NPT conduit connection

(viii) Mounting bracket kit

4. Building Pressurization Instrumentation

a. Provide an Air Monitor Corporation S.O.A.P. (Shielded Outdoor Air Probe) device. Install per manufacturer's recommendation.

b. Indoor reference points shall be located as indicated on the drawings. Typically, points shall be located in a large, open area away from building entrances.

C. Humidity Sensors:

1. Vaisala HMD60U or HMW60U Humidity Transmitter, or ACI (Automation Components INC.) – A/RH2-O for outdoor application .shall be installed. Accuracy of +/- 2% RH and a 4-20 mA output required.

2. Transmitter shall have zero and span adjustments on the device.

D. OCCUPANCY SENSORS

1. Occupancy sensors (auto on/off) and vacancy sensors (manual-on, auto-off) shall be used.

2. Sensors shall be dual-technology type unless specifically contradicted for the application
 3. Sensors shall be provided with extra set of auxiliary contact for VAV, and other TAB box controls.
 4. Areas with automatic lighting controls shall have isolated output relay to HVAC DDC controls, independent of any manual override.
 5. Contractor shall provide a plan view drawing with occupancy sensors location and their coverage area and associated DDC control devices.
 6. Manufacturers: Hubbell, Watt Stopper, Leviton, Sensor Switch. Or equivalent.
- E. Carbon Dioxide Sensors:
1. CO₂ sensors shall use single-beam dual-wavelength non-dispersive infrared sensor.
 2. Sensor shall be accurate to within 2.5 percent of full scale reading. Range shall be 0 – 2000 ppm. Sensor must provide long-term stability of ±5 percent of full scale for a minimum of 5 years.
 3. Output shall be a 4-20 mA signal.
 4. ACI CO₂ sensors -Wall Mounted: A/ESENSE-R, Duct Mounted CO₂ sensor: A/ESENSE-D, Outdoor CO₂ sensor: A/ASENSE Outdoor; Vaisala GMW86P, Vaisala GMD20 duct mounted sensor.
 5. Transmitter shall have zero and span adjustments on the device.
- F. Carbon Monoxide / Nitrogen Dioxide Sensors:
1. Sensors shall be electrochemical sensors for the detection of carbon monoxide and nitrogen dioxide.
 2. Sensors shall have an accuracy of +/- 2% and a minimum sensor life expectancy of 3 years and shall be field replaceable.
 3. Transmitter shall provide two separate proportional 4-20 ma outputs for carbon monoxide and nitrogen dioxide. The carbon monoxide analog output shall be ranged 0-100 ppm and the nitrogen dioxide output shall be ranged 0-30 ppm.
 4. The transmitter shall have visible LED indication of proper sensor operation and shall be equipped with a manual jumper selection to drive the 4-20 ma outputs to selected values for testing interfacing to DDC systems or other devices.
 5. The unit shall be an MSA ZGARD DS model Nema 4X enclosure , ACI Q5- smart gas transmitter toxic and combustible sensor
 6. Transmitter shall have zero and span adjustments on the device.
- G. Airflow Measuring Stations
1. Duct mounted airflow measuring stations utilizing thermal dispersion technology. Each sensing point shall measure both airflow and temperature using a pair of instrument grade, hermetically sealed, glass encapsulated thermistors. Thermistors resistance/temperature characteristics shall be traceable to NIST calibration standards.
 2. Each measurement location shall produce a single, linear isolated 4-20 ma analog output signal for airflow and/or temperature where indicated. The system shall have the ability to perform self-diagnostics and produce an alarm, which can identify the source of malfunction. In the event of a sensor failure, the system shall ignore failed sensor(s), average remaining sensors and shall continue to operate. The unit shall be equipped with a 16 character alpha-numeric LCD display.

3. Sensor shall have an accuracy of $\pm 2.0\%$ of reading with $\pm 0.25\%$ repeatability. Sensors shall operate over a temperature range of $-20\text{ }^{\circ}\text{F}$ to $160\text{ }^{\circ}\text{F}$ and a relative humidity range of 0% to 99% (non-condensing). Electronics shall operate over a temperature range of $-20\text{ }^{\circ}\text{F}$ to $120\text{ }^{\circ}\text{F}$
4. The number of independent sensing points shall be per manufacturer's recommendations for the specified application as shown on drawings. The probe body shall be constructed of extruded aluminum alloy. Provide airflow straightening devices as per manufacturer's recommendations if the required minimum diameters of straight duct upstream and downstream of the device cannot be achieved in the area where the device is to be installed as designated on drawings.
5. The Sensor shall be located in straight ductwork section where linear air flow is obtained. The sensor will have good access including access door when needed. If the sensor is located in Outside Air stream then filter will be provided upstream from this instrument. Instrument location shall be inspected by the manufacturer representative prior to installation to verify size and location. Prior to startup of air handling systems, A.F.M. instruments shall be tested and calibrated by the manufacturer representative and written report shall be submitted to the owner.
6. The unit shall be an Ebtron Model GTA116-PC Thermal Dispersion Airflow measurement or VOLU-flo/OAM Air Monitor Corporation for minimum outside air application. Install in min. outside air damper.

H. Signal Converters and Isolators

1. Isolation Modules – PR Electronics 4116 with 4501 LCD display. Isolation Modules shall be used when a voltage or current signal is transmitted between 2 devices that do not share the same power supply. They can be used to convert from current to voltage or vice versa and rescale the signal to an appropriate range. Protect each signal converter individually with Class CC fuse, or equivalent. Fuse holder shall be Bussmann Model CHCC, or equivalent. Mount Modules to DIN rail.
2. Electronic to Pneumatic Transducers – Converts 4-20 mA or 2-10 Volt input signal to a 0-15 psig output. Output signal shall be linear to the input signal. Johnson Controls EP-8000 or equivalent. Also, Electronic to Pneumatic transducer shall have a zero and span adjustment.
3. Pneumatic to Electric Switches: Shall have adjustable setpoint with scale and adjustable differential. Voltage and amperage ratings of the contacts shall not be exceeded.
4. Pneumatic to Electronic Transducers: Advanced Control Technologies PTP 3/15.

I. Power Supplies and Noise Suppression Devices

1. 24 Volt DC Power Supply
 - a. Size Power supply a minimum of 33 percent larger than the total connected load to allow for expansion. Fuse the supply circuit at no more than 150 percent of full load capacity of the power supply. Fuse shall be Class CC, or equivalent. Fuse holder shall be Bussmann Model CHCC or equivalent, DIN Rail mounted.
 - b. The output of the Power supply shall provide short-circuit protection.
2. Power Conditioners
 - a. All microprocessor based controllers shall be powered from a 120 VAC circuit protected by a noise suppression device. The device shall provide a line regulation of $\pm 1\%$ and have a noise attenuation of 40 dB. The audible noise valve shall be less than 65 dBA.

Provide overload capacity of 165 percent of rated current. Output harmonic distortion shall be less than 3 percent of RMS content.

- b. Sola CVS Power Conditioner – Transformer shall be sized based on a load but no greater than 150% of the connected load 23 -22- 112 -2 (120 VA), 23-23-125-8 (250 VA) or 23-23-150-8 (500 VA).
 - c. The Line side of the conditioner shall be protected by a Class RK1 fuse, Bussmann model LPN or equivalent, sized per Power Conditioner manufacturers requirements. The Load side of the conditioner shall be protected by a Class CC fuse, or equivalent. Load side fuseholder shall be Bussmann Model CHCC or equivalent, DIN Rail mounted. Maximum load side fuse size shall be 7 amperes.
- J. Relays and Switches
1. Mount all relays and power supplies on DIN Rails in a NEMA 1 enclosure beside the DDC panel or in the controlled device and clearly label their functions. A NEMA 12 enclosure is required for outdoor or wet applications.
 2. Control Relays: All Digital inputs/outputs shall use Tyco Gold Contact Relays model KHAU-17A16N, Allen-Bradley 700-HC14A1-4, or *equivalent*. Relay shall use a plug-in socket mount, with finger-safe terminals, Allen-Bradley 700-HN103, or equivalent.
 3. High or Low Air Pressure Safety Switch: Differential pressure switch with double-pole, double-throw snap switch and enclosure.
 - a. Rated for pressure specified in sequence of control for fan system. (–5.5 to 5.5 inch WC. for most AHUs)
 - b. Electrical rating shall be 15 amps at 120-480 volts.
 - c. Setpoint adjustment shall be screw type located inside enclosure.
 - d. Provide optional manual reset for overpressure protection with all tubing, brackets, and adapters.
 - e. Device shall be mounted in a locked control panel.
 - f. Acceptable Manufacturer: Siemens Powers Air Flow Switch 141-0575 or Cleveland AFS460, ACI AFS 460.
 4. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for fully ampacity of wiring or overcurrent protection of circuit controlled.

K. Circuit Protection

Unless specified otherwise, all fuses shall be Class CC, or equivalent. Fuse holders shall be Bussmann Model CHCC or equivalent, DIN Rail Mounted. Maximum size shall not exceed maximum capacity of conductor, or 7 Amps, whichever is less.

2.2 PNEUMATIC SENSORS, SWITCHES, RELAYS, AND INDICATING DEVICES

A. Acceptable Manufacturers

1. ACI – Automation Components Inc.
2. Schneider Electric Building Systems / TAC
3. Siemens
4. Andover
5. Johnson Controls

6. Honeywell

B. Temperature Sensors

1. Immersion Sensors

- a. Sensing element shall be installed within a 316 stainless steel thermowell using a non-hardening heat conducting paste.
- b. Thermowell shall be rated for a minimum static pressure of 500 psig at the maximum operating temperature and be capable of withstanding water velocities of up to 27 fps.
- c. The sensor shall be mounted so that it extends into the flow stream to a minimum of 1/3 of the diameter of the pipe. For pipes greater than 10 inch diameter, thermowell shall be installed in a position 45 degrees from the bottom of the pipe.

2. Duct Mounted Sensors

- a. For mixed air temperature and coil discharge temperature sensing provide a liquid filled averaging sensing element. Sensing element shall have a minimum of 1 foot of sensor length for each 2 square feet of duct or coil area. Sensor shall be arranged evenly across the duct or coil such that no point in the duct or coil is more than 1 foot away from the sensor.
- b. The averaging sensor need to be mounted across a duct in a serpentine fashion with bends in a smooth ark using an M-648-K or CC-1G –K clip. The RTD probe is sensitive for the entire length, while thermistor is sensitive at nine evenly spaced sensor locations. Use standard metal screws to secure to the duct. For duct/coil area 15 SQ. FT. and smaller, temperature sensor shall have minimum of 3 angled passes, and for areas larger than 15 SQ.FT. Averaging temperature sensor shall have a minimum of 4 angled passes. Length of averaging temperature sensor shall be length required to provide adequate coverage on the listed requirements above and manufacturer's requirements.
- c. Install stainless steel flanges where elements penetrate ducts. Support elements with appropriate clips on coil faces, or 1/2" conduit in open ducts and plenums.
- d. Duct Averaging Sensors: **ACI A/IK-2W-A-X'-GD**; **Siemens QAM2012.750** Duct AV SNSR, PT 1K OHM 24'; **BAPI 1K Ohm Platinum –A-X'-BB4**. Averaging sensor length shall be picked based on a coverage area and a coil size, and as recommended in sections listed above, 2.a., 2.b.,2.c.
- e. Duct Point Sensor – T.A.B. Box Sensor Model: **ACI A/IK-2W-D-X''-GD**; **Siemens 536-811 100K** Ohm Duct Temp Sensor; **Siemens QAM2012.045** Duct Pt SNSR, PT 1K OHM; **BAPI Immersion Probe with Nylon Fitting Temp Sensor 1K Ohm Platinum –I-X''-BB4**

3. Space Thermostats

- a. Each thermostat in an office, classroom, lecture hall, laboratory, or other nonpublic area shall incorporate an accessible setpoint adjustment feature.
- b. Each thermostat in a corridor, lobby, atrium, stairwell, lounge, restroom or other public area shall incorporate a blank cover with no adjustment feature.

4. Outdoor Air Temperature

- a. Outdoor Air Temperature shall be a remote bulb liquid filled sensor, preferably located on the north side of the building and shaded with sun shield. Sensor shall be located at least six feet above grade away from window wells and exhaust openings.

C. Pressure Transducers

1. Provide pressure transmitters that provide a direct acting 3 to 15 psig output signal that is linear to the input signal. Select the scale of the pressure transmitter such that the expected control setpoint is in the middle of the range of the transmitter.
2. Differential transmitters shall be selected using the lowest range allowable.
3. On hydronic and steam systems the transmitter shall be rated for liquid service.
4. When measuring steam pressure the transmitter shall be installed lower than the tap from the supply line. Impulse piping shall be long enough to protect the transducer from excessive temperatures and be installed with impulse piping "pigtail", which must be filled with water before startup to prevent damage.

D. Gauges and Thermometers

1. General

- a. Provide 1.5" minimum diameter air pressure gauges for indication of supply and control pressure at all thermostats (except room thermostats), EP valves, PE switches, valves, damper motors, and other points in the system where indication of air pressure is needed for operating and troubleshooting.
- b. Provide 3.5" minimum diameter pressure gauges for indication of pressure at control sensors and monitoring points where indication of system pressure is needed for operating and troubleshooting.
- c. Gauges for control air pressure indication shall be suitable for the application.
- d. Gauges shall be selected to accurately measure all operating pressures and to withstand all expected pressures.
- e. 3.5" size gauges shall be provided with a calibration screw to allow field calibration of gauges with transmitters.

2. Differential Air Pressure Gauge (DPG) for Monitoring Filters

- a. Provide a DPG suitable for internal pressures to 15 psig, accuracy of $\pm 3\%$ of full scale throughout the entire range at 70 degrees F, 4" minimum diameter dials, resistant to shock and vibration. Ranges shown on the drawings.
- b. Provide an adjustable high limit alarm that will be connected to the DDC system to notify the Owner when the filters are dirty. Output shall be Form C dry contacts.
- c. Acceptable Product: Dwyer Series 2000

3. Thermometers

- a. Thermometers shall be alcohol filled glass-bulb or dial type.
- b. Select an appropriate range for each thermometer based on the process being measured. Thermometer shall be able to withstand all expected temperatures without loss of calibration.
- c. Thermometers in hydronic systems shall be installed in immersion wells with a non-hardening heat conducting paste. Separate thermometers shall be installed within 2 feet of each temperature sensor.

2.3 ELECTROMAGNETIC FLOW METERS FOR HYDRONIC SYSTEMS

A. General

1. Provide flow meters as scheduled or otherwise indicated in documents.

2. Flow meters shall be of the electromagnetic type.
 3. Flow meters shall be manufactured in conformance with ISO standards.
- B. Flow Meter Sensor
1. Flow meter shall incorporate ANSI class 150 flanged connections, a full line-size 304 stainless steel flow tube, 316 stainless steel electrodes and inner liner compatible with temperature and chemical content of flow media.
 2. Flow meter shall be rated for 150 PSIG system pressure and shall have adequate structural integrity for flow rate equal to 150% of scheduled maximum initial or future flow rate, whichever is greater.
 3. Flow meter shall be provided with adequate means for grounding process fluid (e.g. grounding rings or grounding electrode).
 4. Flow meter shall be rated for flow media temperature and 140 degrees F ambient air temperature.
 5. Flow meter sensor shall incorporate firmware for storage of pertinent parameters unique to meter.
- C. Liner
1. Liner material shall be EPDM for media temperatures up to 140 degrees F.
 2. Liner material shall be PTFE for media temperatures greater than 140 degrees F.
- D. Transmitter
1. Flow meter shall incorporate remote mounted programmable transmitter that incorporates a digital display.
 2. Transmitter shall be rated for 140 degrees ambient air temperature.
 3. Transmitter cable of 25 ft. minimum length shall be provided with each unit unless otherwise scheduled or noted within project documents. Cable length shall be adequate to satisfy specific installation requirements.
 4. Electrical power input shall be 24VAC or 24VDC unless otherwise indicated within documents to be 120VAC.
 5. Transmitter shall calculate and display flow rate and net totalized flow along with associated engineering units (i.e. GPM and Gal.) on a three line digital display. A password or external key shall be required to alter this display.
 6. Transmitter shall provide two pulsed outputs, no exceptions. One pulsed output shall indicate incremental flow in one direction while the other indicates incremental flow in the opposite direction such that net totalized flow can be calculated remotely.
 7. Transmitter shall produce a 4-20 mA output signal that is directly proportional to volumetric flow rate. A digital output shall indicate direction of flow.
 8. Unless scheduled or otherwise indicated, the initial span adjustment of each transmitter shall be 0-120% of the scheduled maximum flow rate.
 9. Transmitter shall incorporate self-diagnostics and test functions. It shall be capable of accomplishing following without use of external equipment:
 - a. Testing of all outputs and displays.
 - b. Verification of accuracy.
 - c. Verification of current loop integrity.

10. Upon power up, transmitter shall be capable of automatically uploading parameters resident within sensor firmware such that no operator configuration is required.
11. Transmitter shall incorporate a front facing optical port for communication of verified accuracy.
12. Transmitter shall be capable of downloading all test function results into a laptop computer.

E. Accuracy

1. Accuracy of each meter/transmitter assembly shall be $\pm 0.25\%$ of flow rate reading over a range of 3-15 ft/sec fluid velocity, with a repeatability of 0.1%. Accuracy at 1 ft/sec shall be $\pm 0.50\%$.

F. Calibration

1. Each meter shall be calibrated on a NIST traceable flow stand at a minimum of three operating points. These three points shall be the flow rates associated with fluid velocities of 1.0 FPS, 8.0 FPS and 15.0 FPS. Written documentation of calibration shall be provided.
2. Each meter shall have factory fingerprinting to allow NIST traceable in-situ calibration verification to $\pm 1\%$ of original factory calibration.

G. Warranty

1. Provide a one year manufacturer warranty.

H. Basis of Design

1. ABB Watermaster

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.
- B. Verify that all components are installed properly and calibrated to the proper operating range.

3.2 INSTALLATION - GENERAL

- A. Install all components as specified by manufacturer.
- B. All components shall be installed in a neat workmanlike manner.
- C. All wiring and pneumatic tubing shall be labeled on both ends as shown on as-built drawings.

3.3 FLOW METERS

- A. Remote Mounted Transmitter for Flow Meters shall be installed at BAS Control Panel or on wall or structure near flow tube in a clean dry location that is easily visible and with display easily readable.
- B. Each meter assembly shall include detailed installation and operation instructions that include piping straight run requirements. Meter installation needs to ensure the electrodes are always wet along with a maintenance bypass piping.
- C. Each bid shall include the cost of on-site start-up, commissioning and training.
- D. The BAS Contractor shall adjust DDC readout to match the measured airflow rates provided by the Balancing Contractor.

3.4 COMMISSIONING

- A. The instrumentation and controls devices shall be commissioned prior to start-up. .

- B. Provide two seasonal system functional checkouts including seasonal changes (winter and summer modes).

END OF SECTION 230913

SECTION 230913.33 - CONTROL VALVES

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Control Valves for Hydronic Applications
 - 1. HVAC Grade
 - 2. Industrial Grade
- B. Control Valves for Low Pressure Steam Applications
 - 1. HVAC Grade
 - 2. Industrial Grade

1.2 QUALITY ASSURANCE

- A. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

PART 2 - PRODUCTS

2.1 CONTROL VALVE APPLICATIONS

- A. Hydronic Systems (i.e. Water-Based Heat Transfer Systems)
 - 1. All automated valves in hydronic systems shall be rotary type. Modulating control valves shall be either characterized ball or segmented ball type. Modulating control valves in variable flow systems shall be two-way. Two position (on-off) valves shall be either ball or butterfly type. Two valve grades are specified herein, HVAC and industrial grade.

Exception: In a very limited number of cases control valves may be globe type. Typically these are small pneumatically actuated valves given that small pneumatically actuated rotary control valves are not readily available. Valve type shall be as scheduled or otherwise indicated in project documents.
 - 2. In cases where still required, automated building chilled water pressure regulating valves in CHW supply lines shall be industrial grade (segmented ball valves). Also, if two position (on-off) valves in adjacent chilled water return lines are automated they too shall be industrial grade (high performance butterfly valve). If not automated, valves may be HVAC grade (resilient seated butterfly valve).
 - 3. The grade of other automated valves shall be HVAC or industrial as scheduled or otherwise indicated within the documents. Except for retrofit applications, HVAC grade valves shall have electronic actuation. Actuators for industrial grade valves shall be electric or pneumatic as scheduled or otherwise indicated.
- B. Steam Systems
 - 1. Low Pressure (≤ 15 PSIG)
 - a. Modulating control valves in low pressure steam systems may be either HVAC globe valves or industrial grade rotary valves with either electronic or pneumatic actuation as scheduled or otherwise indicated within the documents.

2.2 CONTROL VALVE SIZING

A. Two Position (On-Off) Control Valves

1. Valves shall typically be sized for minimal fluid/steam pressure drop. In such case, valve connection size shall be equal to pipe size with no reducers.
2. In certain cases it may be desirable to serve a modulating load with a two position (on-off) control valve. Examples include fan coil units and other small terminal devices. This approach promotes incremental turbulent flow as opposed to continuous modulating laminar flow during part-load operation: The goal here is to reduce overall flow rate and increase fluid delta T. In such cases it may be appropriate to provide a valve with connection size smaller than line size

B. Modulating Control Valves

1. Control valves shall be sized to operate at no less than 70% of available stroke at maximum flow rate.
2. At minimum flow rate, control valves shall be sized to operate at or above minimum recommended valve position as determined by manufacturer.

C. Modulating Control Valves for Hydronic Applications

1. Unless otherwise scheduled or indicated within the documents, each control valve shall be sized for a full-open fluid pressure drop at design flow rate that is equal to 25-50% of the total pressure drop through the branch or dedicated circuit that it controls. The total branch pressure drop equals the sum of the pressure drops through the branch piping, fittings, controlled equipment, control valve, balancing valve, isolation valves and any hydronic specialties (e.g. strainers). This approach yields .25 to .50 valve authority. Control valve Cv calculation shall be based upon the actual differential pressure required for each valve to achieve this valve authority. The standard practice of using 5 PSID for Cv calculation for all valves throughout the system regardless of location relative to the pump is not acceptable.

D. Modulating Control Valves for Steam Applications

1. For steam supply pressures of 12 PSIG or less, valves shall be sized to yield a gage pressure drop of 80-100% of the inlet gage pressure at the maximum flow rate, unless otherwise scheduled or indicated within the documents.
2. Control valves shall be sized such that the steam velocity at design conditions does not exceed 0.5 mach for limited periods of time (i.e. several hours). Velocity shall not exceed 0.3 mach for extended periods of time (i.e. days on end).

E. Parallel Valves

1. Sliding stem globe valves
 - a. For steam-to-hot water heat exchangers and other high turndown applications a minimum of two control valves shall be provided for each heat transfer device and shall be piped in parallel. In such cases these valves shall be sequenced such that the appropriate sized valve opens first. Sizing of each valve shall be in compliance with the criteria presented above. A common approach to sizing parallel valves is that of selecting one valve for 1/3 of the total system flow rate and another for the remaining 2/3. This rule of thumb approach is not necessarily optimal. Thus, an engineered approach shall be used that optimizes valve sizing and sequencing relative to specific minimum and maximum flow conditions within the system.
2. Bypass valves
 - a. A bypass line with manual throttling valve shall be provided at each steam control valve station, whether it has a single valve or multiple valves in parallel. This manual valve

enables control of steam flow rate if for any reason one or more control valves are disabled. More importantly, it facilitates warm up of the steam system downstream of the control valve(s).

2.3 ADDITIONAL VALVE SELECTION CRITERIA

A. Valve Characteristic

1. Control valves in CHW and HW applications shall have equal percentage characteristic.
2. Control valves in steam applications shall have equal percentage characteristic.
 - a. Equal percentage characteristic is preferred for steam pressures ≤ 12 PSIG

B. Shut-Off Rating

1. Control valve/actuator assemblies in all hydronic systems shall have shut-off ratings of at least 1.5 times the shut-off head of the system pump(s).
2. Control valve/actuator assemblies in chilled water systems shall have shut-off ratings of 50 PSID minimum. This is the anticipated maximum DP in the campus central CHW system.
3. Control valves in all hydronic systems shall have operating differential pressure (dynamic pressure) rating of 50 PSID minimum.

C. Leakage Class

1. Metal-seated valves shall be leakage class IV minimum.
2. Soft-seated control valves shall be leakage class VI unless otherwise specified.

D. Cavitation

1. Control valves shall be selected to meet their intended service without cavitation. If necessary, anti-cavitation trim shall be provided.

E. Noise

1. Control valves shall be selected to meet their intended service without creating objectionable noise.
2. Default maximum sound level shall be 85 dBA at a distance of 5'. This will likely need to be adjusted based upon location, adjacencies, etc.
3. If necessary, noise attenuating trim shall be provided.

F. Velocity

1. As stated above, steam velocity shall not exceed 0.3 mach although in some cases an absolute maximum velocity of 0.5 mach may be considered.

2.4 FAIL POSITION

A. Heating/cooling applications with rotary actuators (e.g. electric, pneumatic rack and pinion).

Fail in last position (non-spring return):

1. Preheat coils
2. Reheat coils
3. Finned tube units
4. Radiant panel heaters
5. Convectors
6. Unit heaters

7. Cabinet unit heats
8. HW fan coil units
9. HW blower coil units
10. Steam-to-hot water heat exchangers that serve all devices listed above
11. Fan coil units – heating coil
12. Blower coil units – heating coil
13. CHW coils not exposed to outdoor air
14. Chilled beams
15. Computer room cooling units
16. Other specialty cooling equipment

Fail open (spring return or electronic):

1. Chilled water coils potentially exposed to outdoor air*

* HVAC grade rotary valves are available with factory mounted actuators with electronic fail safe feature in lieu of spring return mechanism (e.g. Belimo “super-capacitor”. HVAC grade rotary valves with such factory mounted actuators are allowed although valves and actuators must satisfy all other specified requirements.

B. Heating/cooling applications with pneumatic spring-and-diaphragm actuators

Fail open:

1. Preheat coils
2. Finned tube units
3. Radiant panel heaters
4. Convectors
5. Unit heaters
6. Cabinet unit heaters
7. Fan coil units – heating coil
8. Blower coil units – heating coil
9. Steam-to-hot water heat exchangers that serve all devices listed above
10. Fan coil units – cooling coil
11. Blower coil units – cooling coil
12. CHW coils potentially exposed to outdoor air

Fail closed:

1. Reheat coils
2. Steam-to-hot water heat exchangers that serve them

C. Safety related applications with spring-return rotary or spring-and-diaphragm actuators.

Fail closed:

1. Domestic water heaters

2. Steam humidifiers
 3. Process equipment
 4. Other potentially hazardous applications
- D. Cooling tower applications
1. Condenser water bypass – Fail closed
 2. Cooling tower shut-off (individual cells) – Fail closed
 3. Cooling tower makeup – Fail open
 4. Cooling tower blow-down – Fail closed
 5. Cooling tower winter drains – Fail open

2.5 ACTUATORS

A. Valve actuators

1. Refer to *Section 23 09 13.34 – Control Valve Actuators* for actuator specifications

PART 3 - EXECUTION

3.1 INSTALLATION

A. Accessibility

1. Control valves shall be located for ease of access to valve and actuator for service and removal/replacement.

B. Unions/Flanges

1. Pipe union or flanges shall be provided on each side of each control valve to facilitate removal and replacement.

C. Strainers

1. Line-size strainer shall be provided in piping system upstream of each control valve.

3.2 ORIENTATION

A. Rotary Control Valves

1. For hydronic applications, valve shall be oriented with shaft horizontal. In no case shall valve be installed with shaft oriented vertically downward (i.e. with actuator at bottom). Exception: Small rotary valves with electronic actuators (e.g. at reheat coils and fan coil units) may be installed in any orientation.
2. For steam applications, valve shall be oriented with shaft horizontal. In no case shall valve be oriented in vertically upward position. Vertical upward orientation results in overheating of actuator and accessories.
3. Valve shall be installed such that the preferred direction of flow as indicated within product literature matches the actual direction of fluid flow through the valve

B. Sliding stem (e.g. globe) control valves

1. For hydronic applications, valve shall be installed such that stem is oriented within 45 degrees of the vertical upward position. If this orientation cannot be practically achieved, valve may be installed such that stem is oriented horizontally. In no case shall valve be installed such that stem is oriented vertically downward.
2. For steam applications, valve shall be installed such that stem is not oriented in the vertically upward position to prevent overheating of actuator and accessories. Preferred orientation is

45 degrees from vertically upward position. If this orientation cannot be practically achieved, valve may be installed such that stem is oriented horizontally. In no case shall the valve be installed such that stem is oriented vertically downward.

3. For all applications valve shall be installed such that direction of flow indication on valve body and/or product literature matches actual direction of fluid flow through valve.
4. Manufacturer's recommended straight pipe length shall be provided upstream and downstream of valve.
5. Velocity in piping upstream and downstream of steam valve shall not exceed manufacturer's recommended maximum.

3.3 INSULATION

A. Insulated Piping Applications

1. Control valves in insulated piping systems shall have bodies, flanges, etc. completely insulated. This applies to valves in heating systems (i.e. steam and hot water) as well as those in cooling systems. Practice of leaving heating valves and associated unions/flanges un-insulated is not acceptable. Steam valves shall be insulated such that actuator and accessories are protected from excessive convective and radiated heat.
2. Insulated valves shall be equipped with extended stems and protective shields as required to allow operation without disturbing insulation.

END OF SECTION 230913.33

SECTION 230913.34 - CONTROL VALVE ACTUATORS

PART I - GENERAL

1.1 SECTION INCLUDES

- A. HVAC Grade Actuators
 - 1. Electric
 - 2. Pneumatic
- B. Industrial Grade Actuators
 - 1. Electric
 - 2. Pneumatic

1.2 COMPLIANCE

- A. Products and execution shall be in compliance with all applicable codes and standards.
- B. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

PART 2 - PRODUCTS

2.1 CONTROL VALVES

- A. Valve/Actuator Combinations
 - 1. Proper combination of control valve and actuator shall be provided for application.
- B. Failure Mode
 - 1. See *Section 23 09 13.33 Control Valves* for failure mode for given application.

2.2 POSITIONERS

- A. Positioners shall be provided as scheduled or otherwise indicated in project documents.
- B. Positioners are typically required on modulating control valves that serve central station equipment (e.g. AHUs, heat exchangers). If not scheduled or otherwise indicated in project documents, positioners shall be provided as a default requirement for modulating valves serving central station equipment.
- C. When multiple valves are sequenced with one another, a positioner shall be provided on each valve (e.g. parallel control valves at heat exchangers).

2.3 POSITION FEEDBACK

- A. Position feedback shall be provided as scheduled or otherwise indicated in project documents including control drawings and specifications.
- B. Position feedback shall be provided on all modulating rotary control valves larger than 2".

PART 3 - EXECUTION

3.1 WIRING METHOD

- A. Electronic Actuators
 - 1. If actuator is provided with both conduit connector and prewired cable, conduit connector shall be used.
 - 2. If provided with conduit connector, final connection to actuator shall be made with flexible metal conduit.

3. If provided with prewired cable only, cable shall be terminated within junction box or enclosure. Junction box shall be located near actuator to prevent free-air splice.
4. Rubber strain relief grommet shall be provided at junction box or enclosure to protect cable from damage.

3.2 ORIENTATION

A. Rotary Control Valves/Actuators

1. For hydronic applications, preferred valve orientation is with shaft oriented horizontally. Valve shall not be installed such that shaft is oriented vertically downward (i.e. with actuator at bottom). Exception: Small rotary valves with electronic actuators (e.g. at reheat coils and fan coil units) may be installed in any orientation.
2. For steam applications, valve/actuator shall be installed such that shaft is oriented horizontally. In no case shall shaft be oriented in vertically upward position. Vertical upward orientation results in overheating of actuator and accessories.

B. Linear (Sliding Stem) Control Valves/Actuators

1. For hydronic applications, valve/actuator shall be installed such that stem is oriented within 45 degrees of vertical upward position. If this orientation cannot be practically achieved, valve may be installed such that stem is oriented horizontally. In no case shall valve be installed such that stem is oriented vertically downward.
2. For steam applications, valve/actuator shall be installed such that stem is not oriented in vertically upward position. Vertical upward orientation results in overheating of actuator and accessories. Preferred orientation is 45 degrees from vertically upward position. If this orientation cannot be practically achieved, valve may be installed such that stem is oriented horizontally. In no case shall valve be installed such that stem is oriented vertically downward.

3.3 MOUNTING BRACKET

A. Standoff

1. As applicable, actuator mounting bracket shall have adequate standoff to accommodate insulation. In steam applications mounting bracket shall have adequate standoff to protect actuator from excessive radiant, convective and conductive heat.

B. Isolation

1. In steam applications, actuator mounting bracket and linkage shall provide adequate isolation to protect actuator from excessive conducted heat.

3.4 SPECIAL NOTE

A. Electronic Actuators

1. Electric/electronic actuators are especially vulnerable to damage by heat (radiant, convective and conductive). It is essential that they be installed in strict compliance with requirements of 3.1 and 3.2 above.

END OF SECTION 230913.34

SECTION 230913.43 - CONTROL DAMPERS

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Airfoil Dampers, Heavy Duty Galvanized Steel
- B. Thermally Insulated Dampers, Heavy Duty Galvanized Steel
- C. Airfoil Dampers, Aluminum - Ultra Low Leakage
- D. Thermally Insulated Dampers, Aluminum – Ultra Low Leakage
- E. Control Damper Actuators

1.2 QUALITY ASSURANCE

- A. Installation shall be in compliance with Manufacturer's recommendations and installation instructions.

1.3 CERTIFICATION

- A. Dampers shall be licensed to receive the *AMCA* seal.

1.4 DAMPER APPLICATIONS

- A. Isolation
 - 1. For on-off or isolation applications parallel blade dampers shall be used.
- B. Modulating Control
 - 1. For modulating control applications opposed blade dampers shall typically be used.
 - 2. Given that parallel and opposed blade dampers have different flow characteristic (performance curve) in some cases a parallel blade damper may be a better selection for modulating service than an opposed blade damper.
- C. Mixed Air Economizer
 - 1. There is no "one size fits all" approach to damper selection and sizing for mixed air applications. A system approach shall be taken that selects damper type based upon characteristic and damper size based upon authority. More often than not optimal design yields opposed blade outside air and relief dampers and "smaller" (in relative terms) parallel blade return dampers. Percent minimum outdoor airflow and relative pressure drops through air paths are key inputs into proper damper sizing.
- D. Minimum Outdoor Air
 - 1. Minimum outdoor airflow dampers shall typically be opposed blade type.
- E. Face and Bypass
 - 1. For two-position bypass or two position face and bypass applications parallel blade dampers shall be used.
 - 2. For modulating face and bypass applications opposed blade dampers shall typically be used.

1.5 DAMPER SIZING

- A. Opposed Blade Damper
 - 1. Modulating opposed blade control dampers shall be sized for a full-open air pressure drop at design flow rate that is equal to 10% of the total pressure drop through the "controlled air path". This approach yields a damper authority of 10%. For duct mounted applications

opposed blade dampers shall typically be smaller than duct size. See schedule for damper size and/or discuss with PSC to confirm proper sizing.

B. Parallel Blade Damper

1. When used for isolation (open-close, parallel blade dampers shall be sized for minimal pressure drop. For duct mounted applications parallel blade dampers shall typically be full duct size.
2. When used for modulating control, parallel blade dampers shall be sized for a full-open air pressure drop at design flow rate that is equal to 30% of the total pressure drop through the controlled air path yielding a damper authority of 30%. For duct mounted applications parallel blade control dampers shall typically be substantially smaller than duct size.

1.6 FAIL POSITION

A. Control dampers shall fail to "safe" position

1. Outdoor air economizer damper – Fail closed
2. "Minimum outdoor air" damper – Fail closed
3. Relief air economizer damper – Fail closed
4. Return air economizer damper – Fail open
5. Exhaust fan dampers – Typically fail closed
6. Associated makeup air dampers – Typically fail closed
7. VAV terminal unit dampers – Typically fail open
8. Face and bypass dampers – Typically fail open to face, closed to bypass

PART 2 – PRODUCTS

2.1 AIRFOIL DAMPERS, HEAVY DUTY GALVANIZED STEEL

A. Frame

1. Galvanized steel channel
2. 12 gauge minimum
3. Reinforced corners for increased rigidity

B. Blades

1. Galvanized steel
2. 16 gauge minimum
3. Airfoil shape
4. 8" maximum individual blade height

C. Axles (Pins)

1. Stainless steel
2. Non-cylindrical drive pin to prevent slippage of actuator drive mechanism (e.g. hexagonal shape, with set screw "flat", or similar)
3. Drive pin length adequate for mounting direct-coupled actuator
4. Drive pin extension and outboard bearing support bracket as required

- D. Bearings
 - 1. Stainless steel
 - 2. Thrust bearings as required for vertical blade orientation
- E. Blade Edge Seals
 - 1. Mechanically attached to blade, adhesives and clips not allowed
 - 2. Neoprene, EPDM or Silicone as scheduled and or/as appropriate for application
- F. Jamb Seals
 - 1. Compressible stainless steel
- G. Linkage
 - 1. Stainless steel
- H. Face linkage, exposed in airstream
- I. Jack Shafts
 - 1. Jack shafts shall be pre-manufactured and mounted at the factory
 - 2. Jack shaft assemblies, including shaft, bearings, bearing supports and linkage shall be of comparable construction and quality as damper components specified above.
- J. Ratings
 - 1. Temperature
 - a. Conservatively rated for specific application
 - b. 400 degrees F rating for steam heating applications
 - c. Rating applied to all components including blade edge seals, jamb seals and bearings
 - 2. Pressure
 - a. Rated for 1.25 x system design static pressure, 4" w.c. minimum
 - 3. Velocity
 - a. Rated for 1.25 x system design velocity, 2000 FPM minimum
 - 4. Leakage
 - a. Allowable leakage: AMCA Class 1
 - b. 4 CFM / SF at 1" w.c. differential pressure
 - c. 8 CFM / SF at 4" w.c. differential pressure
 - 5. Pressure Drop
 - a. Allowable pressure drop for 24"x24" damper
 - b. 0.15" w.c. at 2,000 FPM
- K. Size
 - 1. 48" maximum blade length
 - 2. 16 sq. ft. maximum overall damper area
 - 3. Exceptions may be considered on a case by case basis
- L. Basis of Design
 - 1. Ruskin CD30AF

2.2 THERMALLY INSULATED AIRFOIL DAMPERS, HEAVY DUTY GALVANIZED STEEL

- A. Thermally insulated heavy duty galvanized steel airfoil dampers shall satisfy all requirements specified above in paragraph entitled *AIRFOIL DAMPERS – HEAVY DUTY GALVANIZED STEEL*.
- B. Exceptions:
 - 1. Frame and blades shall be insulated, filled with high density foam
 - 2. Basis of Design: None

2.3 AIRFOIL DAMPERS, HEAVY DUTY STAINLESS STEEL

- A. Heavy duty stainless steel airfoil dampers shall satisfy all requirements specified above in paragraph entitled *AIRFOIL DAMPERS, HEAVY DUTY GALVANIZED STEEL*.
- B. Exceptions
 - 1. Frame and blades shall be type 304 or type 316 stainless steel.
 - 2. Blade edge seals shall be silicone.

2.4 THERMALLY INSULATED AIRFOIL DAMPERS, HEAVY DUTY STAINLESS STEEL

- A. Thermally insulated heavy duty stainless steel airfoil dampers shall satisfy all requirements specified above in paragraph entitled *THERMALLY INSULATED AIRFOIL DAMPERS, HEAVY DUTY GALVANIZED STEEL*.
- B. Exceptions:
 - 1. Frame and blades shall be type 304 stainless steel.
 - 2. Blade edge seals shall be silicone.

2.5 AIRFOIL DAMPERS, ALUMINUM – ULTRA LOW LEAKGE

- A. Frame
 - 1. Extruded aluminum channel
 - 2. 12 gauge minimum
- B. Blades
 - 1. Extruded aluminum
 - 2. Airfoil shape
 - 3. Double overlap design
 - 4. End caps or equivalent to minimized jamb seal abrasion
 - 5. 8" maximum individual blade height
- C. Axles (Pins)
 - 1. Solid aluminum or zinc plated steel
 - 2. Geometric shape (e.g. hexagonal) to match blade opening
 - 3. Drive pin length adequate for mounting direct-coupled actuator
 - 4. Drive pin extension and outboard bearing support bracket as required
- D. Bearings
 - 1. Celron inner bearing rotating within a polycarbonate outer bearing or equivalent synthetic bearing elements with no metal-to-metal or metal-to-plastic contact
 - 2. Thrust bearings as required for vertical blade orientation

- E. Blade Edge Seals
 - 1. Secured in integral slot
 - 2. Double overlap design
 - 3. Extruded silicone
- F. Jamb Seals
 - 1. Secured in integral slot
 - 2. Extruded silicone or equivalent low-friction synthetic material
- G. Linkage
 - 1. Aluminum and/or corrosion-resistant zinc plated steel
 - 2. Accessible in airstream. Exception: Linkage may be located within frame if dampers are flanged and are easily removable from duct or have full exterior access
- H. Jack Shafts
 - 1. Jack shafts shall be pre-manufactured and mounted at the factory
 - 2. Jack shaft assemblies, including shaft, bearings, bearing supports and linkage shall be of comparable construction and quality as damper components specified above.
- I. Ratings
 - 1. Temperature
 - a. Conservatively rated for specific application
 - b. 400 degrees F rating for steam heating applications
 - c. Rating applied to all components including blade edge seals, jamb seals and bearings
 - 2. Pressure
 - a. Rated for 1.25 x system design static pressure, 4" w.c. minimum
 - 3. Velocity
 - a. Rated for 1.25 x system design velocity, 2000 FPM minimum
 - 4. Leakage
 - a. Allowable leakage: AMCA Class 1
 - 1) 3 CFM / SF at 1" w.c. differential pressure
 - 2) 8 CFM / SF at 4" w.c. differential pressure
 - 5. Pressure Drop
 - a. Allowable pressure drop for 24"x24" damper
 - b. 0.15" w.c. at 2,000 FPM
- J. Size
 - 1. 48" maximum blade length
 - 2. 16 sq. ft. maximum overall damper area
 - 3. Exceptions may be considered on a case by case basis.
- K. Basis of Design
 - 1. Tamco Series 1500

2.6 THERMALLY INSULATED DAMPERS, ALUMINUM – ULTRA LOW LEAKAGE

- A. Aluminum thermally insulated dampers shall satisfy all requirements specified above in paragraph entitled *THERMALLY INSULATED AIRFOIL DAMPERS – HEAVY DUTY GALVANIZED STEEL Frame*
 - 1. Insulated, filled with closed cell foam
- B. Blades
 - 1. Insulated, filled with high density foam
- C. Basis of Design
 - 1. Tamco Series 9000

2.7 CONTROL DAMPER ACTUATORS

- A. Electronic Actuator, Spring Return
 - 1. Direct mount type with V bolt clamp and matching cradle. Single bolt or setscrew fasteners not acceptable.
 - 2. NEMA rated as appropriate for application/location. Actuators for outdoor applications shall be NEMA 4 rated.
 - 3. Brushless DC motor
 - 4. 24 VAC or 24 VDC power supply
 - 5. 0-10, 2-10 VDC or 4-20 mA control input
 - 6. Signal inverter switch
 - 7. Fully modulating/proportional or two position as scheduled or indicated in control schematic/sequence.
 - 8. Automatic stroke calibration
 - 9. Spring return for fail-safe operation.
 - 10. 60,000 cycle rated
 - 11. 50% duty cycle rated
 - 12. Sized for 150% of maximum damper torque requirement
 - 13. Rated for 120 degree F ambient temperature
 - 14. Motor overload/stall protection throughout rotation
 - 15. Visual position indicator
 - 16. Manual mechanical override
 - 17. 3' (minimum) prewired cable or 1/2" conduit connection as appropriate for application
 - 18. Approved for plenum application as required
 - 19. Two adjustable SPDT auxiliary switches (end switches) for position indication as scheduled or indicated in control schematic/sequence
 - 20. Electric analog feedback. Provide only if scheduled or otherwise indicated in documents
 - 21. Adequate mounting height to accommodate 2" thick duct insulation
 - 22. Multiple tandem-mounted actuators not allowed
 - 23. Two-year unconditional warranty
 - 24. Approved manufacturers: Belimo, Siemens, Schneider/TAC

- B. Pneumatic Actuator, Spring Return
 - 1. Aluminum or steel housing with swivel connection
 - 2. Spring-loaded piston with replaceable rolling molded synthetic rubber diaphragm
 - 3. Chrome plated or stainless steel shaft with swivel ball joint and crank arm connector
 - 4. Sized for 150% of maximum damper torque requirement at 15 PSIG control air pressure
 - 5. Relay type pneumatic positioner
 - 6. Two adjustable SPDT auxiliary switches (end switches) for position indication as scheduled or indicated in control schematic/sequence
 - 7. Rated for 25 PSIG control air pressure
 - 8. Rated for -20 to 150 degree F ambient temperature

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General
 - 1. Dampers shall be provided as shown on drawings, scheduled and/or otherwise indicated in project documents.
 - 2. Dampers shall be automated via electronic or pneumatic actuation unless clearly indicated in design documents as manually operated.
- B. Control Damper
 - 1. Damper frame as well as associated duct opening shall be completely square (i.e. not "racked") to prevent binding.
 - 2. Metal angle shall be provided all around (all four sides) within duct/frame and rigidly attached. Damper frame shall be attached to angle rather than duct, thus providing free-play for adjustment of damper within duct prior to permanent attachment.
 - 3. Damper shall be installed with blades horizontal unless other orientations (e.g. vertical) are approved by manufacturer.
 - 4. Each damper shall be installed such that blades and any face linkage are fully accessible from within duct, plenum, air handling unit, etc. If damper linkage is located within frame, flange mounting shall be provided. Flange mounting shall allow full exterior access to linkage or easy removal of damper from duct. Adequate clearance shall be provided relative to adjacent ductwork, piping, etc.
 - 5. Sizable access door(s) shall be provided such that dampers are easily accessible for inspection, repair or replacement.
 - 6. After installation, each damper shall be opened and closed manually prior to actuator mounting to ensure smooth operation.
 - 7. Structural bracing shall be provided for multiple section assemblies to support assembly weight and hold against system pressure. Bracing shall be provided at every horizontal and vertical mullion.
- C. Control Damper Actuator, Electronic
 - 1. Actuator shall be direct mounted on associated damper drive shaft.
 - 2. One actuator shall be provided for each damper section. No actuator shall serve more than one damper section. Multiple tandem-mounted actuators are not allowed.
 - 3. Actuators shall be installed outside of airstream if possible, especially outdoor airstream.

D. Control Damper Actuator, Pneumatic

1. One actuator may be used to power multiple damper sections.
2. Blade-to-blade "jumper" brackets not allowed. Jack shaft must be used to drive multiple sections.
3. Actuator shall be installed outside of airstream to prevent exposure to freezing temperatures.

E. Control Damper Operator, Manual

1. Manual operator shall be factory manufactured for such application and damper design and shall include positive locking mechanism.

END OF SECTION 230913.43

SECTION 230923 - BUILDING AUTOMATION SYSTEM (BAS) FOR HVAC

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Standalone Digital Controllers
- B. Network Interface Modules
- C. Application Specific Controllers
- D. Integrating Subsystem Controllers
- E. Control Devices, Components, Wiring and Material
- F. Instructions for Owners

1.2 ACRONYMS

- A. Acronyms used in this specification are as follows:
 - 1. ASD Application Specific Device
 - 2. ALN Area Level Network
 - 3. BAS Building Automation System
 - 4. BLN Building Level Network
 - 5. CER Communication Equipment Room
 - 6. CSMA/CD Carrier Sense Multiple Access / Collision Detect
 - 7. DDC Direct Digital Control
 - 8. HHOT Hand Held Operator's Terminal
 - 9. IP Internet Protocol
 - 10.FLN Field Level Network
 - 11.LAN Local Area Network
 - 12.LEED Leadership in Energy and Environmental Design
 - 13.NEC National Electric Code
 - 14.NCU Network Control Unit
 - 15.NIM Network Interface Module
 - 16.P&ID Piping & Instrument Diagrams
 - 17.PID Proportional, Integral, Derivative
 - 18.SDC Stand-alone Digital Controller

1.3 DEFINITIONS

- A. BAS (Building Automation System)
 - a. Devices, conduit, wire, programming and protocols required for operation of a building's environmental control systems. Major systems and units controlled include items such as Chilled Water Distribution, Air Handling Units, DOA units, Chillers, Boilers, Heat Exchangers, and Hot Water Distribution.

- B. Networks: in order of speed / hierarchy.
1. LAN (Local Area Network) Ethernet Communications Network by *Information Technology Services*
 2. BLN (Building Level Network) / ALN (Area Level Network)
 - a. Communication Network between SDC's inside the building.
 - b. Acceptable Protocols used for communication include:
 - (a) Schneider Electric Building Systems I/A Series: BACnet I/P
 - c. Used to communicate between BAS devices installed within the building.
 - d. Higher Speed
 3. FLN – Field Level Network
 - a. Communications network between ASD's, SDC's
 - b. Acceptable Protocols used for communication include:
 - (b) Schneider Electric Building Systems I/A Series: BACnet MS/TP
- C. Specific Control Component Devices
1. ASD (Application Specific Device)
 - a. Communicates on the FLN
 - b. Contains Analog / Digital I/O points.
 - c. Typically used on Terminal Units such as VAV's, Fan Coils.
 - d. Can "Fully Load", e.g. does not need spare I/O Point capacity.
 2. NCU (Network Control Unit)
 - a. Device which communicates between LAN and BLN
 - b. May have capability to directly control Analog / Digital I/O points.
 3. NIM (Network Interface Module)
 - a. Device which communicates between LAN and BLN.
 - b. Has no capability to directly control Analog / Digital I/O points.
 4. SDC (Stand-alone Digital Controller)
 - a. Device which communicates between LAN and BLN
 - b. May also communicate to devices on FLN.
 - c. Has capability to directly control Analog / Digital I/O points.
 - d. Design so that unit uses only 80% of total I/O capacity to allow for future expansion without immediate need for an additional I/O module.

1.4 SYSTEM DESCRIPTION

- A. DDC System: The BAS-Building Automation System shall be a direct digital control (DDC) system which can, without additional equipment, perform all of the automatic temperature control and energy management functions as required in this specification. DDC shall be defined as a control technique through which the process is continuously monitored by a digital computer that accomplishes loop control by calculating a control solution for output to a control device. Each DDC building automation system for HVAC shall be network of independent stand-alone digital controllers (SDC's). Each SDC shall be capable of full control either as a completely independent unit or as a part of a building wide control system. Each SDC shall be capable of communicating with each other without the use of a central host computer within the building level network. Each SDC shall directly communicate to abuilding Network Interface Module (NIM) which shall be connected to the campus Ethernet. Each SDC shall be provided with two Ethernet connections, one for the controller (native Ethernet protocol) and other for a portable laptop computer. The system, as specified, shall independently control the building's HVAC equipment to maintain a comfortable environment in an energy efficient manner. Each DDC system shall accommodate internet enabled viewing of the control system. All building level network controllers shall be native Ethernet peer to peer architecture. Floor level network devices shall be DDC devices as well provided with native manufacturer's protocols specified in this standard. System components

shall be fully compatible with existing systems from the same vendor on the campus of the University of Illinois at Springfield.

- B. Site License: Approved vendors have systems at this campus with a site license covering all system software which has been documented, approved and signed by all parties. The site license shall be maintained by the University with the vendor in contracts negotiated outside of this project contract. Client Licenses shall be utilized and provided by vendor under this contract where required by this project's system.
- C. Client License: Where required by the system architecture, the vendor shall provide a Client License for utilization at the project site. In addition, a client license shall also be provided to the Owner with each new project added to the system.

1.5 SUBMITTALS

- A. General: Submit documents under provisions of Division 01. Two (2) printed copies of the materials shall be delivered directly to the Owner, in addition to the copies required by other Sections. In addition, an electronic version of the completed materials shall be provided on CD or DVD. Refer to *Section 01 91 13 – General Commissioning Requirements* and *Section 23 08 00 – Commissioning of HVAC* for additional Commissioning submittal requirements.
- B. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and operation and maintenance (O&M) information shall also be provided in electronic format as follows:
 - 1. Drawings and Diagrams: Shop Drawings shall be provided on electronic media as an AutoCAD drawing per Owner's CAD standards. All 'x reference' and font files must be provided with AutoCAD files.
 - 2. Other Submittals: All other submittals shall be provided in Adobe Portable Document Format.
- C. Equipment Coordination:
 - 1. The Building Automation Systems (BAS) Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
 - 2. Control valve selections shall be based on control valve schedule and flow rates shown in Construction Documents.
 - 3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.
- D. Shop Drawings Grouped into Separately Phased Submissions: Submit Shop Drawings in groups to be reviewed at appropriate phases of the construction execution. Groups shall be established and submitted such that components and equipment requiring the longest lead time and/or greater coordination efforts are reviewed and approved first. A suggested grouping and order of submission is as follows:
 - 1. First Submission:
 - a. Proposed point names (prior to beginning any programming effort.) Do not begin programming effort until the Owner has approved the point names.
 - b. Main Valves and their actuators
 - c. Boilers, Chillers
 - d. AHU's, Heat Recovery Units
 - e. System Architecture and System Layout
 - 2. Second Submission
 - a. Unitary Controllers, VAV's
 - b. Dampers and their actuators
 - c. Air Flow Measuring Stations
 - d. Schematic Flow Diagrams

- e. Schematic Diagrams
 - f. Points List
 - g. Sequences
 - h. Product Data of all control devices, panels and accessories
3. Third Submission
- a. Graphics Pages
 - b. Programming, Block Diagram format and native program language with annotation and documentation.
 - c. Schematic Wiring Diagrams
 - d. **Provide a power line diagram with quantity and location of transformers indicated on the diagram and plan view drawings.**
- E. Shop Drawings: Submit Shop Drawings electronically on AutoCAD software for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Shop Drawings shall contain the following information:
- 1. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.
 - 2. Submittal shall include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
 - 3. System Architecture and System Layout: Provide One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate Ethernet backbone number, network number, device ID, address, device instance, MAC address, object ID (object type, instance number), drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram. Include interface requirements with other systems, including but not limited to, security and surveillance systems, lighting control, elevator status, power monitoring systems and door access systems.
 - a. Provide floor plans locating all control units, workstations, servers, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate Ethernet network number, network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.
 - 4. Diagrams shall include:
 - a. Wiring diagrams and layouts for each control panel showing all termination numbers.
 - b. Schematic diagrams for all control, communication and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
 - c. Identification of all control components connected to emergency power.
 - d. Schematic diagrams for all field sensors and controllers.
 - e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.

- f. A schematic *wiring* diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
 - g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
 - h. All installation details and any other details required to demonstrate that the system will function properly.
 - i. All interface requirements with other systems.
5. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, If this information is not available at the time of Shop Drawings submittals, furnish with O&M manual documentation for Owner review and approval. See *Section 01 33 23 – Shop Drawings, Product Data, and Samples* and *Section 01 78 23 – Operation and Maintenance Data* for additional requirements.
 6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.
 7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 8. Points List Schedule: Submit a complete points list of all points to be connected to the BAS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points list, point naming convention, and factory support information for systems provided and integrated into the BAS.
 9. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices.
 - a. Include written description of sequence of operation on the Schematic Flow diagram to match components and system shown.
 - b. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table
 10. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:
 - a. Damper Identification Tag.
 - b. Location.
 - c. Damper Type.
 - d. Damper Size & Quantity.
 - e. Duct Size.
 - f. Arrangement.
 - g. Blade Type.
 - h. Velocity Pressure Drop.
 - i. Fail Position
 - j. Actuator Identification Tag

- k. Actuator Type & Quantity.
 - l. Mounting.
11. Valve Schedule: BAS Contractor shall size the control valves and provide Cv. Schedule shall include a separate line for each valve and a column for each of the valve attributes:
- a. Valve Identification Tag.
 - b. Location.
 - c. Valve Type.
 - d. Valve Size.
 - e. Pipe Size.
 - f. Configuration.
 - g. Flow Characteristics.
 - h. Capacity.
 - i. Valve Cv.
 - j. Design Pressure Drop.
 - k. Pressure Drop at Design Flow.
 - l. Fail Position.
 - m. Close-off Pressure.
 - n. Valve and Actuator Model Number and Type.
12. Airflow Measuring Station (AFMS) Schedule:
- a. The manufacturer's authorized representative shall prepare the airflow measuring station submittal, or review and approve in writing the submittal prepared by the BAS Contractor prior to submission to the AE and prior to installation. The representative shall review air handling equipment submittals and duct fabrication drawings to ensure that all AFMS locations meet the appropriate parameters to achieve proper installation and the specified accuracy. Comply with all manufacturer's installation requirements including straight up and downstream duct lengths. Install airflow straighteners if required by the manufacturer based on installation constraints. The AE shall be notified for approval of any deviations.
 - b. Submit product data sheets for airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.
 - c. Submit installation, operation, and maintenance documentation.
13. Product Data: Submit manufacturer's engineering and technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Include installation and start-up instructions for each BAS system component.
14. Provide Graphics Pages to be utilized on Operator Work Stations and Web Access. Sample shall be submitted and approved prior to deployment to system components. See Part 2 of this specification for requirements.
15. Provide copy of program to be utilized in each device for approval by the Owner prior to deployment. Submit information in block diagram format (VISIO) as well as in native program language. Submittal shall include all appropriate documentation, commenting and notation to facilitate understanding and troubleshooting the system.
16. Label each control device with setting or adjustable range of control.
17. Label each input and output with the appropriate range.
18. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.

19. With each schematic, provide valve and actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers.
 20. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination Drawings on separate Drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring that are existing, factory-installed and portions to be field-installed.
 21. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
 22. Sheets shall be consecutively numbered.
 23. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
 24. Table of Contents listing sheet titles and sheet numbers.
 25. Legend and list of abbreviations.
- F. Training Manual:
1. Provide Course Outline and training manuals for each class. Refer to the paragraph entitled "Training" in Part 3 of this section.
- G. Record Documents:
1. Update and include all information noted in the Shop Drawing section.
 2. Record copies of product data, as built control Shop Drawings and final sequence of operation updated to reflect the final installed condition.
- H. Provide as-built network architecture Drawings showing all nodes including a description field with specific controller identification, description and location information.
- I. As-Built Control Diagram: Provide complete operating data, system drawings, wiring diagrams, and written detailed descriptions of sequences. One copy of the as-built control diagram shall be placed inside each control panel. Provide metallic pocket inside the door large enough to hold complete drawings. Electronic set to be provided to the Owner commencing with start of Warranty period.
- J. Operation and Maintenance Data:
1. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
 - a. Include systems descriptions, setpoints, and controls settings and adjustments.
 - b. Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
 2. Submit BAS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
 3. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.
 4. Manufacturer's Certificates: For all listed and/or labeled products, provide certificate of conformance.

5. Product Warranty Certificates: Submit manufacturer's product warranty certificates covering the hardware provided.
- K. Actual Locations: Include actual location of control components, including panels, thermostats, and sensors, not already included in as-built drawings. Include revised shop drawings to reflect actual installation and operating sequences.
- L. Calibration Report: The BAS Contractor shall submit to the Owner a calibration report of all final slopes, intercepts and/or offsets for all devices prior to final witnessing by the Owner. See Part 3 of this specification for requirements.
- M. Commissioning Report: At completion of Work, submit commissioning report of automatic control system.

1.6 WARRANTY

- A. Components: Provide one-year warranty on all materials and labor, after commissioning is complete and accepted by Owner.
- B. Software Upgrades: Requirements shall include furnishing and installing all BAS software upgrades issued by the manufacturer for one year beyond the warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Schneider SmartStruxure Building Systems, I/A Series or pre-approved successor installed by Alpha Controls & Services
- B. Apogee Building Automation System, or pre-approved successor installed by Siemens
- C. Metasys Building Automation System, or pre-approved successor installed by Johnson Controls Incorporated

If Equipment Controllers including: Chillers controllers, Boilers controllers, Humidifiers controllers are provided on a project, then those controllers and associated peripherals will be commissioned, and functionally tested per project application and sequence of operation by the "factory representative. Temperature Control Contractor will be responsible to **fully integrate and map** associated peripherals physical and virtual control IO points, and shall comply with UIS standards and UIS point naming convention per project application. Temperature Control contractor shall be responsible to provide all necessary drivers and integration components to fully integrate these controllers.

Laboratory Equipment Controllers – Fume Hood Controls System shall be designed to be part of larger building network, and shall communicate directly with all make up air handling DDC controls system. Acceptable Manufacturers are: A. Siemens BACnet laboratory controllers with Siemens main head-end with a Siemens Blade damper air valve, and B. Schneider main head-end with Accutroll and /or Phoenix fume hood air valves integrated via Schneider SmartStruxure building automation system. Network Integration of laboratory fume hood controllers **will not** be allowed via LON based system (LonWorks not allowed).

Energy Recovery Wheel Specifics – Energy Recovery Wheels shall be controlled from main air handling unit DDC controller and by DDC approved manufacturers as listed in paragraph 2.1 Building Automation System Acceptable manufacturers. Energy recovery Wheel freeze protection sequence shall be provided and incorporated in a control sequence. Purging and crawling operation modes shall be designed based on project needs and manufacturers recommendations.

2.2 SYSTEM ARCHITECTURE

- A. SDC: The system shall be a network of independent stand-alone digital controllers (SDCs). Each SDC shall provide full control either as a completely independent unit or as a part of a

building-wide control system. Each SDC shall be capable of and provide peer-to-peer communication without the use of a central host computer within the building level network. Systems that use a master/slave arrangement shall have all master units communicating with each other. New systems shall communicate directly to existing SDCs, application specific devices (ASDs), network interface modules (NIMs), or network control units (NCUs) within the building. They shall be backward compatible with existing systems of the same manufacturer, or they shall provide a new network interface and all associated hardware.

- B. Communication: Each NCU shall directly communicate to the campus Ethernet via an IEEE 802.3 compliant Ethernet connection. Each NCU or NIM shall communicate with the central host computer and other NIMs on the system via an Ethernet connection. Communication to all primary SDCs within the building shall be via native Ethernet network interfaces using TCP/IP protocols and manufacturer's native UDP protocols to exchange information in a peer to peer network. All communications shall be complete and fully operational before the commissioning is started. Two network connections shall be provided at each NCU or NIM.
- C. NCU's shall connect SDC's or floor level ASD devices via a manufacturer's approved native RS-485 protocol or via a BACnet MSTP (Master-Slave Token Passing Bus).
- D. Programming: A single control programming language shall be used and shall be fully programmable from the central host computer, which shall also function as the database server. The system shall utilize client/server architecture, with all points and program databases stored on the server central host computer. All operator workstations shall serve as clients.
- E. **Licensing**: Provide additional client licenses, programming and engineering tools for the installed Systems to the Owner.

2.3 BAS CONTROLLERS AND ACCESSORIES

A. General

1. Multiple Building Functions: BAS Contractor shall furnish and install a BAS capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.
2. System Components: BAS shall consist of, but not be limited to, the following:
 - a. Standalone DDC Panel(s). See definition of SDC, ASD, NIM, and NCU.
3. Future Expansion: System shall be modular in nature, and permit expansion of both capacity and functions through addition of sensors, actuators, panels, and operator devices. System architecture shall support expansion capacity of all types of DDC panels, and all point types included in the initial installation. There shall be a minimum of 10 percent of each type of I/O point available for expansion on each of the SDCs. If multiple SDCs are mounted in a single location, 10 percent of each type of I/O point type must be available in the group.
4. Self-Diagnostics: The BAS shall contain self-diagnostics that continuously monitor the integrity of the system. Any malfunction of the system shall be reported to the Central Host Computer to inform the operator of the nature of the malfunction and the NIMs, NCUs, or SDCs affected.
5. Battery: Each SDC shall include its own microprocessor-based controller, power supply, input/output modules, termination modules and a rechargeable Lithium battery. The battery shall be capable of supporting all memory and the real time clock within the control unit for a minimum of 72 hours if the external power to the unit is interrupted or lost.
6. 72 Hour Memory: Upon loss of external power to any SDC, the other units within the network shall not be affected, and the loss of operation of that unit shall be reported at the designated operator's terminal. All control strategies and energy management routines defined for the SDC shall be retained during a power failure via the battery within the unit for a minimum of

- 72 hours. Upon resumption of commercial power, the SDC shall resume operation without operator intervention. The unit shall automatically reset its clock such that proper operation of timed sequences is possible without the need for manual reset of the clock.
7. Local Operator Interface: All SDCs and NCU's shall contain the necessary equipment for direct interface to the sensors and actuators connected to it from a portable operator's terminal.
 8. Safety: The control unit shall be listed by Underwriters Laboratories (UL KK864) against fire, smoke control, and shock hazard as a signal system appliance unit. All SDCs, NIMs, and NCU's shall be enclosed in a hinged metal enclosure. All control panels shall be located away from sources of heat and humidity and away from the primary equipment room entry and exit paths.
 9. Power Conditioner: Each SDC, NCU, and NIM shall receive isolated conditioned power from a 120 volt power conditioning constant voltage transformer manufactured by Sola/Hevi-Duty. Unit shall be a hevi-duty CVS series unit or pre-approved equal. One power conditioner may be used to power multiple controllers. The power conditioner shall be sized to allow for the addition of at least 1 controller, but sized no greater than 150% of the connected load. Isolated/un-isolated power shall not be mixed in the same conduit or raceway. The Line side of the conditioner shall be protected by a Class RK1 fuse, Bussmann model LPN or equivalent, sized per manufacturers requirements. The Load side of the conditioner shall be protected by a Class CC fuse, Bussmann model KTK, or equivalent. Load side fuse holder shall be Bussmann Model CHCC, or equivalent.
 10. Wiring by BAS Contractor: All wiring for the BAS panels, including power and sensor wiring, shall be by the BAS Contractor. All internal control panel wiring shall conform to the UL508A standard. All external wiring entering BAS panels shall terminate on a terminal strip within the panel and be labeled appropriately. All internal wiring within panel shall be labeled on both ends.
 11. NEC Compliant Wiring: All wiring shall be installed in conduit and shall conform to *Division 26 - Electrical* of these specifications and the National Electrical Code. Conduits shall not be filled more than 75 percent of the NEC rating to allow for future expansion.
 12. Standard Non-Proprietary Components: System shall include all hardware, software, equipment, accessories, wiring, piping, relays, sensors, power supplies, and instrumentation required for a complete and operational system. All materials and equipment shall be standard non-proprietary components regularly manufactured for this and/or other systems and not custom-designed specifically for this project. All components shall have been thoroughly tested and proven in actual use.
 13. Graphical Representation: The BAS shall monitor and control equipment as called for by the "Sequence of Operation" including, but not limited to, the points list. Any additional system components required for proper operation but not necessarily mentioned shall also be included. A graphical representation of each system shall be made available on all operator workstations displaying all control and monitoring points and alarms. Graphical representation shall be web accessible. See paragraph entitled "GRAPHICAL REPRESENTATION" below for specific requirements.
 14. Independent Panel Operation: System design shall eliminate dependence on any single device for alarm reporting and control execution.
 - a. Each BAS panel shall operate independently in performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt execution of control strategies.
 - b. Critical Loop I/O Control Functions shall have the devices wired directly to the controller. Owner shall have final authority regarding definition of what constitutes a Critical Loop.

B. Programmability

1. Point Termination: All primary inputs and outputs of control loops shall be terminated on the SDC performing the loop calculations. Secondary inputs, such as reset inputs, may be shared via the RS-485 bus. The control action taken by the SDC upon loss of communications to the source of the shared input shall be clearly defined if these points are not terminated on the SDC.
2. SDC Fully Programmable: All SDCs shall be fully programmable from any operator workstation.

C. Network Interface Modules (NIMs)

1. NIM: The BAS Contractor shall provide a minimum of 1 high speed Network Interface Module (NIM) for each building which supports both of the following types of communication standards between SDCs and other NIMs on the network: Two IEEE 802.3 compliant Ethernet network connections shall be provided at each NIM allowing campus Ethernet connection. Each Building Network Controller, CPU memory usage shall remain 80 percent of its total capacity.
 - a. Ethernet: The BAS-LAN shall employ Carrier Sense Multiple Access/Collision Detect (CSMA/CD) contention type protocol, which adheres to the industry standard format IEEE 802.3. The content of messages shall be the manufacturer's standard. The BAS-LAN components shall be manufacturer's standard or available from third party vendors that utilize the same chip implementation as used by the manufacturer. In addition Ethernet NIMs shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3 compliant Ethernet Networks. Ethernet NIMs shall directly support connectivity to 10/100 twisted pair RJ-45 terminated UTP category 6 cabling.
2. RS-485: At data rates of up to 19.2 Kbaud, the trunk distance shall be extendible to distances of up to 20,000 feet using RS-485 communication wire or fiber optic repeaters. A repeater shall be used each 4,000 feet of linear distance for wire or every 6,500 feet for fiber optics or at intervals as required by the manufacturer for proper system operation. Repeating devices shall contain separate LED indication for each communication interface trunk to indicate proper operation of the repeater as well as the communication trunks. Contractors shall provide devices that are of the BAS control system manufacturer's design, and shall provide a trunk riser diagram showing end to end distances and locations of system topology necessary to meet the trunk diagram shown on the plans. Each multi-drop shall support a minimum of 24 SDCs. Systems that communicate on a current loop or any other industry standard communication link will be accepted.
3. Transient Surge Protection: The manufacturer's catalog data sheet shall provide evidence that all BAS products offered by the manufacturer are tested and comply with the standard for Transient Surge, and can withstand capabilities for electrical devices ANSI C62.41, IEEE-587-1980, Categories A and B. Such testing shall have included power and communication trunk wiring. Compliance with IEEE-587 shall imply conformance with IEEE-472 transient standards based on the stated position of ANSI and IEEE regarding applicability of the rated standards. In addition, at each building entry and exit point, the wire communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection specifications of the General semiconductor, Model #422E device. Transient surge protection is not necessary if the communication trunk, external to the building, is fiber optic in nature. The communications circuitry, including phone, and input/output circuitry, of the SDCs shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations. The manufacturer's catalog data sheet shall provide evidence of conformance with this requirement. Systems not complying with this requirement shall provide equivalent protection external to the BAS controller. Protection shall be provided for the individual communications and input/output terminations for each

BAS controller. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

D. Standalone Digital Controllers (SDC)

1. Independent SDC at All Times: Standalone Digital Controllers (SDCs) shall be minimum 16 bit microprocessor based, utilizing a multi-tasking, multi-user operating system. The SDCs shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or Owner. Modification of the on-board SDC controller database shall be performed on-line using a laptop computer connected via a local RS-232 port or Ethernet via Host System.
2. True Floating Point Arithmetic Capabilities: SDCs shall utilize true floating point arithmetic capabilities. To accommodate totalization of large totalized values, SDCs with reporting capability shall support the calculation, accumulation and display of values within the range of +/-10 to the 10th power.
3. Operator Service Port: SDCs shall be equipped with an operator service port for the connection of a laptop computer. The service ports shall be a built-in RS-232 data terminal port. An optional RJ-11 type jack that connects to the manufacturer's standard HHOT may be included in addition to the RS-232. Connection of a service device to a service port shall not cause the SDC controller to lose communications with its peers or other networked device controllers. The service ports shall allow utilization of the same laptop computer program or HHOT (hand held operator's terminal) from any location. The same laptop computer program or HHOT shall be utilized for any SDC or NIM. Systems that utilize more than one variety of laptop computer program or HHOT are not acceptable.
4. Override Capability: The SDC shall provide commanded override capability from the laptop computer or HHOT. Such overrides shall be annunciated to the Central Host Computer. Such overrides shall be valid as long as power is applied to the controller. SDC indication of such manual override actions shall be provided as feedback status indication points shown on the Drawings, in conjunction with the application programs within the SDC. H/O/A switches remotely located at the SDC controller shall be behind a locked panel or capable of being disabled through the control program.
5. Adjustments: Every SDC shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel, or adjustments to other parameters as specified. Adjustments shall be integral to each individual SDC. From a single SDC user interface, any other SDC on the network shall be accessible and full adjustment capabilities shall be provided.
6. Metal Enclosures: All SDCs, or any device not classified as an ASD controller, shall be enclosed in metal enclosures with suitable brackets for either wall or floor mounting and shall be furnished and installed with each system. They shall be fabricated from either steel or extruded aluminum and shall be equipped with hinged door and lock. Panels shall not be secured to any item of equipment. Metal enclosures shall be provided to all SDCs and ASD controllers on all new projects and any upgrade/ retrofit projects as well.

E. Network Control Unit (NCU)

1. A Network Control Unit (NCU) is a SDC incorporating a built-in NIM. The NCU shall incorporate all of the features of the SDCs and NIMs as outlined above.

F. Application Specific Devices (ASD)

1. Independent ASD Operation At All Times: Application Specific Devices (ASD) shall utilize a multi-tasking, multi-user operating system. The ASDs shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or Owner. Modification of the on-board ASD controller database shall be performed on-line using a laptop computer connected via a local

port or from an Operator Workstation. Systems that require the ASD to be removed from service while BAS control sequences are modified are not acceptable.

2. Power Loss Protection: All programming defining the functions to be performed by the ASD, including but not limited to application programs and point database within each ASD, shall be protected from loss due to power failure. Systems providing non-volatile memory for these functions are preferred. Systems not providing non-volatile memory shall provide a system rechargeable battery backup system sufficient to provide protection. Systems not in compliance shall provide for uninterrupted power to each ASD.
3. Operator Service Port: ASDs shall be equipped with an operator service port for the connection of a laptop computer. The service ports shall be a built-in data terminal port. Connection of a service device, to a service port, shall not cause the ASD controller to lose communications with its peers or other networked device controllers. The service ports shall allow utilization of the same laptop computer program or HHOT from any location. The same laptop computer program or HHOT shall be utilized for any ASD or NIM.
4. Adjustments: Every ASD shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel, or adjustments to other parameters as specified. Adjustments shall be integral to each individual ASD. From a single ASD user interface, any other ASD on the network shall be accessible and full adjustment capabilities shall be provided.

G. Communications

1. NIMs and NCUs: NIMs and NCUs shall be capable of peer-to-peer communications to all other controllers from the same manufacturer connected to the campus Ethernet system.
2. SDCs and ASDs: SDCs and ASDs shall be capable of peer-to-peer communications at the building network level. Primary SDC's shall be capable of peer-to-peer communications at the building network level and have capability to communicate to the central server at the physical plant via campus Ethernet system.
3. Sensor Input Signals
 - a. Each SDC and ASD shall be capable of direct interface to industry standard sensors and input signals. All signal inputs shall be compatible with the controllers used, and with the requirements for readout of variables in true scaled engineering units as specified. Temperature, humidity, differential pressure signals, and other signal inputs shall be one of the following types:
 - (a) 0-20 mA
 - (b) 4-20 mA
 - (c) 0-5 VDC
 - (d) 0-10 VDC
 - (e) 1000 ohm platinum (at 0° C, 2.62 ohms/ °C)
 - (f) 10 k ohm Thermistor (at 25°C/77°F)
 - (g) Custom, definable input signals (accept sensor inputs from RTD devices, other than those of the manufacturer).
 - b. The SDC and ASD shall also be capable of monitoring 2 and 3 state status of starters, fans, H-O-A switches, etc. Isolation relays with bifurcated gold contacts shall be used on all digital or binary inputs (Tyco KHAU17A16 or pre-approved equal).
 - c. The SDC and ASD shall also be capable of monitoring pulse accumulator inputs from sources such as power meters and flow meters which provide a scaled pulse output.

- d. Each electronic analog input shall have the capability of accepting 2 wire inputs and shall be terminated on screw type terminals.
 - e. Sensors based on proprietary equipment shall not be acceptable.
 - f. Thermocouples are not acceptable.
4. Actuators Output Signals
- a. Each SDC shall directly control electronic actuators and controlled devices. Standard analog output signals that shall be provided are:
 - (a) 4-20 mA
 - (b) 0-10 VDC
 - b. Pneumatic devices shall be controlled through an E/P Device. The E/P Device shall have output scaled to 0-15 psi. The E/P device shall utilize 4-20 mA / 0-10 VDC.
 - c. The SDC shall be capable of performing 2 and 3 state output functions to emulate H-O-A switches, contact closures, etc. Isolation relays shall be used to drive fan and pump starters piloted by the digital outputs of the SDC. See *Section 23 09 13 - Instrumentation and Control Devices for HVAC* for device specifications.
 - d. Modulating outputs shall be industry standard 0-5 VDC, or 0-12 VDC with definable output spans, to adapt to industry available control products. Milliamp outputs of 0-20 mA or 4-20 mA are also acceptable. Drive open/Drive closed type modulating outputs are acceptable provided that they also comply with the following requirements. All modulating outputs shall provide within the control panel, a meter gauge, or display indication via on board display or HHOT, the commanded position signal for the actuating device. This meter, gauge, or display shall provide either a 0-100 percent position indication, or read out directly in the engineering units of the signal being used. Drive open/drive closed type controllers shall include sufficient components and control algorithms to comply with this requirement. In the case of drive open/closed technology, position feedback or a software calibration sequence shall ensure that the controlled device is at the commanded position.
 - e. Pilot positioners shall be installed on all valve and damper actuators serving primary mechanical equipment such as AHUs, heat exchangers, etc.
- H. Proprietary Software
- 1. If the BAS Contractor wants a signed licensing agreement for proprietary software, he shall develop one that is mutually agreeable to both parties, prior to requesting its execution. Failure to initiate this process in a timely fashion shall not interfere with progress and completion.

2.4 GRAPHICAL REPRESENTATION

A. General Requirements:

- 1. Graphics Title: Provide a prominent, descriptive title on each graphics page.
- 2. System Status: To facilitate the debugging / testing phase and final delivery of graphics screens to the Owner, each graphics screen shall indicate system function as follows:
 - a. UNDER CONSTRUCTION.
 - b. INSTALLATION AND START-UP.
 - c. SYSTEM OFF-LINE.

3. SYSTEM ON-LINE.Dynamic Update: When the workstation is on-line, all graphic I/O object values shall be updated with change-of-value services, or by operator selected discrete intervals.
 4. Graphic Linking: Forward and backward linking shall be provided between floor plans, sub-plans, summaries and equipment down to application-specific screen.
 5. Resolution and Color Representation: Graphics shall be clear and legible to a screen minimum resolution of 1280 x 1024 pixels. Background shall match existing EcoStructure graphics.
- B. Building Main Navigation Screen:
1. Provide at least one Building Main Navigation Screen that contains links to all mechanical systems including Air Handling Units, Heat Exchangers, Heat Recovery Systems, and Central Systems (like Chilled Water Load, Condensate Flow, Utility Consumption, etc.) in the building. The Building Main Navigation Screen shall show system mode and alarm status.
 2. A link shall be provided from the Building Main Navigation Screen to an accurate AHU zone plan (floor plan). See paragraph below for AHU zone plan requirements.
 3. A link shall be provided from the Building Main Navigation Screen to the VAV Navigation Screen. See paragraph below for the VAV Navigation Screen requirements.
 4. The upper right hand corner of this Building Main Navigation Screen shall contain a dynamic display of the following information:
 - a. Global Outside Air Temperature.
 - b. Global Outdoor Air Humidity.
 - c. Global Outdoor Air Dew Point.
 - d. Global Outdoor Air Enthalpy.
 5. The top middle of the page shall list the Building Name and Building Number. Also, a link shall be provided to the main "Illinois" BAS home page, which contains a list of active links to all the campus buildings.
- C. AHU and Other Mechanical Equipment Graphics Screens (Heat Exchangers, Enthalpy Wheels, Boilers, Chillers, etc.)
- (Graphic details provided for AHU as an example).
1. Provide at least one Graphic display for each Air Handling Unit. (Graphic must include entire AHU and it associated points and elements. Putting an AHU on multiple graphics is not acceptable) Indicate in the top of the screen (above the graphics): Building Name, Building Number, Air Handling Unit Name, Air Handling Unit Number, and Unit Location (mechanical room number). Graphically show the mechanical systems in as-built condition (i.e. do not use generic drop-in graphics). Include a standard AHU graphics library with all of the controls instruments and mechanical devices and associated set points. Locate all instruments and control objects on the drawing (e.g. By-Pass Dampers, Control Dampers, Control Valves, Freeze-Stats, etc.) as they are installed in the field.
 2. Control Points, Set Points and text shall be clearly listed and exposed in a box next to each instrument.
 3. Reset schedules shall be adjustable from the graphic.
 4. Each control Set Point including Set Points that are being reset shall have override capabilities from the Graphic.
 5. Show all Controls Inputs (AI, DI) and and Controls Outputs (AO, DO) on the screen.

6. All Physical Points and Set Points shall be trended and have a hyperlink to their trended data. The hyperlink shall display a minimum of 7 days of trend data for the associated point in a graphical chart.
 7. There shall be a hyperlink to the AHU Schedule on the Graphic
 8. The Owner shall be able to perform troubleshooting from this graphics screen.
 9. The upper Bar shall contain hyperlinks to the following: AHU scheduling, AHU VAV Tables, and any related Graphic Screens or files such as the Sequence of Operation.
 10. The Lower section of the Graphic shall contain the system Mode Status, Mode Set Points for Chilled Water, Preheat, Economizer, Coil pumps, related control parameters including Occupied Status, OA , Ra Enthalpy and Energy Recovery Wheel Enthalpy etc.
 11. This graphics screen shall have a link to the most current version of the written Sequence of Operations. The Sequence of Operations shall be updated at the end of the Project to reflect as-built conditions. A printable version of the Sequence of Operations shall be supplied as part of the graphics.
 12. Provide color-coded floor (zone) plan with AHU service zones including hallways, etc. Multiple floor plans shall have a consistent color-code among floor plans. Distinct colors shall be used to clearly differentiate between zones, and a legend shall be provided if needed for clarity. If used, indicate and provide links to sub-plan areas. Emulate the project's drawings for the zone plan backgrounds. Where applicable, include the mechanical room, HVAC equipment and control components locations, with corresponding links to the main mechanical pieces of equipment and AHU. Links to these zone plans shall be provided from the Building Main Navigation Screen. These floor plans (zone drawings) shall reside in the control system database.
- D. VAV / Terminal Units, Fan Coil Units and/or other HVAC Equipment Graphics Screens:
1. A VAV Main Navigation Screen shall be provided, containing links to all VAV Summary Tables and VAV Small Scale Zone Plans. A link to this VAV Main Navigation Screen shall be provided from the Building Navigation Screen.
 2. VAV box and other HVAC equipment listing shall be provided in a form of a matrix or table on a summary table page. The table header shall include the following: Building number, AHU number servicing the associated VAV boxes, Room Number (location of VAV box), and all main performance parameters including Fan Command and Status, VAV Flow and Flow Set Point (CFM), Damper Position, Room Set Point, Room Temperature, VAV Discharge Air Temperature (Auxiliary Temp), Reheat Valve Position, Radiation Valve Position and Occupancy Mode. On this same page, provide an AHU operation information box which displays the AHU discharge (supply) air temperature, occupancy mode and supply static. A link to each VAV Summary Table shall be provided from the VAV Navigation Screen.
 3. In addition, small scale floor plans shall be provided to show a graphical presentation of the VAVs FCUs etc. and the AHU locations and service areas. This will include the Room Temp and Set Point. The display shall be spectrum and fade to red when hot and blue when cold based off of deviation from Set Point. A link to each VAV small scale zone plan shall be provided from the VAV Navigation Screen .
 4. A link (from both the VAV summary table and the VAV small scale zone plan) to each individual VAV box shall be provided, showing a two or three dimensional drawing (i.e. a zoomed in view of the VAV /Terminal Unit controls detailed drawing). This detailed VAV / Terminal Unit graphic screen shall have all control details including control set points, alarm condition, and signals going IN and OUT of VAV box /Terminal Unit. Each set point shall have override capability (dampers modulation, re-heat valve, etc.). Each point and Set Point shall have a hyperlink to their trended data. The hyperlink shall display a minimum of 7 days of trend data for the associated point in a graphical chart.

E. Trends:

1. Trending of all IO points is required including all air handling systems AHU & DOAs, FCU-fan coil units and ATU / VAV boxes, etc. As a minimum, fan operation, control valve actuation, dampers actuation, setpoints, calculated control values such as enthalpy, safeties and system temperatures shall be trended. Also, all physical IN and OUT points shall be trended. **Include all trends offline or archived.**

2.5 EXTENDED BAS SYSTEM COMPONENTS

- A. Extended to Database Server: The BAS system described in this Section shall be extended to the database server via the campus Ethernet system. The system shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3 compliant Ethernet Networks.
- B. Complete Operating System: The Contractor shall provide all hardware, cards, network controllers, transducers, software, programs, communications wiring, modems, devices and any other components required to make a complete operating system.

PART 3 - EXECUTION

3.1 CONFIRMATION OF POINT NAMES

- A. The Contractor shall submit their proposed point names to the Owner for review and approval prior to beginning any programming. The Contractor shall not begin their programming effort until the Owner has approved the point names.

3.2 EXAMINATION

- A. Acceptance of Conditions: Verify that systems are ready to receive Work. Beginning of installation means Installer accepts existing conditions.
- B. Integrate Existing System: Identify existing BAS controllers within the building and include an integration plan to utilize the existing system if it is from the current approved vendor list.

3.3 INSTALLATION

- A. Manufacturers Instruction: Install in accordance with manufacturers instruction.
- B. Verify Locations: Verify locations of thermostats, humidistats, and other exposed sensors with Drawings and room details before installation. Locate top of each room thermostat a maximum of 48 inches above the floor.
- C. Controller Installation: Mount controllers on freestanding angle iron or uni-strut supports in areas away from direct sources of heat or water and out of high traffic areas. One rack may be expanded to accommodate multiple controllers in the same equipment room.
- D. Adjacent to Associated Equipment: Mount controllers and control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in the same equipment room.
- E. NEC Compliant: Provide NEC compliant conduit and electrical wiring for all temperature control wiring per *Division 26 – Electrical* of these specifications. All low voltage wiring (0-40 Volts), control/power wiring (110 - 120 Volts), and pneumatic tubing shall be run in their own separate raceways.
- F. Test and Adjust: After completion of installation, test and adjust control equipment and programming.
- G. Calibration: Check calibration of instruments. Recalibrate or replace noncompliant equipment.
- H. All Low voltage cable shall be installed per Division 26 requirements.

3.4 COMMISSIONING

- A. Calibration Report: The BAS Contractor shall submit to the Owner a calibration report of all final slopes, intercepts and/or offsets for all devices prior to final witnessing by the Owner. Documentation shall include all Contractor notes and verifications such as point-to-point checkout sheets and shall be appended to contractor-completed Functional Performance Procedures (FPPs). The calibration report shall include all real and virtual points, including energy calculations when included in vendor's equipment (such as for energy recovery wheels). Follow this specification and coordinate with all Commissioning Specification Sections in the Project.

3.5 TRAINING

- A. Upon completion of the work and after User acceptance of Functional Performance testing, on-site training shall be provided by an instructor thoroughly familiar with the installed system. Training will be provided to the Owner's operating personnel who have responsibility for the mechanical and control systems. The training shall focus on operation and maintenance of the installed system.

END OF SECTION 230923

SECTION 232000 - PIPE JOINING

PART I - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Soldering
 - 2. Brazing
 - 3. Threading
 - 4. Flanges
 - 5. Welding
 - 6. Heat Fusion Welding

1.2 DEFINITIONS

- A. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
 - 3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.
- B. Abbreviations:
 - 1. %: Percent
 - 2. ASME: The American Society of Mechanical Engineers
 - 3. ASTM: American Society for Testing and Materials
 - 4. AWS: American Welding Society
 - 5. C: Degrees Celcius
 - 6. E.g.: Exempli gratia "for example."
 - 7. Etc.: Et cetera "and other similar things"
 - 8. F: Degrees Fahrenheit
 - 9. In or ": Inches
 - 10. NPT: National pipe thread
 - 11. PP: Polypropylene piping. Requires Owner approval.

12. PP-R: PP random copolymerized piping. Requires Owner approval.
13. PP-RCT: PP random crystallinity temperature piping. Requires Owner approval.
14. PSIG: Pounds-per square-inch gauge pressure
15. UIS: The University of Illinois at Springfield
16. WPS: Weld Procedure Specifications

1.2 QUALITY ASSURANCE

- A. Joints shall be warranted to be free from leaks and imperfections for same time period. Defective joints shall be repaired or replaced at no cost to Owner.
- C. Installation and operation shall be in compliance with Manufacturer's recommendations, requirements, and installation, operations, and maintenance manuals.

1.3 SUBMITTALS

- A. Product Data
 1. Solder and flux
 2. Brazing filler metal and flux
 3. Flange Gaskets: Type, material, construction, temperature/ pressure rating
 4. Bolts and Nuts: Type, material, ASTM identification
 5. Weld consumables
- B. Documentation
 1. Welder qualifications
 2. Welding procedures
 3. Field records
 4. Field test reports

1.4 PRODUCT DELIVERY, HANDLING AND STORAGE

- A. Materials shall be stored indoors protected from temperature, physical damage and exposure to fluids, dust and debris. Containers of solder, brazing and weld consumables, pastes and fluids shall remain sealed until use. Opened containers shall be kept sealed when not in use.

1.5 WARRANTY

- A. Products and installation thereof shall be warranted to be free from defects in material and workmanship for period of one year from date placed into useful service or 18 months from date of delivery, whichever occurs first. Defective product shall be repaired or replaced at no cost to Owner.
- B. Joints shall be warranted to be free from leaks and imperfections for same time period. Defective joint shall be repaired or replaced at no cost to Owner. Impacted piping system shall be manipulated as required to make repair and fluid media shall be brought back to original condition and fill volume at no cost to Owner.

PART 2 - PRODUCTS

2.1 DISSALLOWED PIPE JOINING METHODS

- A. Roll groove or cut groove joints
 1. For exception see *Section 23 21 13 – Hydronic Piping*

- B. Press-connect joints
 - 1. For exception see Section 23 21 13 – *Hydronic Piping*
- C. Mechanically formed extruded outlets
- D. Piercing valves and fittings
- E. Saddle connections
- F. Welded branch connections
- G. Reducing bushings and flanges
- H. Dielectric unions or fittings
 - 1. For exception see *Section 23 21 13 – Hydronic Piping*
- I. Other non-standard pipe joints

2.2 PIPE AND FITTINGS

- A. Pipe, Fittings, Unions, Flanges
 - 1. See *Section 23 21 13 – Hydronic Piping* for specifications
 - 2. See *Section 23 22 13 – Steam and Condensate Piping* for specifications

2.3 SOLDER JOINTS

- A. Fill Material
 - 1. ASTM B32 alloy E
 - a. 95% tin, 5% copper
 - 2. ASTM B32 alloy HB
 - a. Tin-antimony-copper-zinc-silver
 - 3. Disallowed: 95-5 (95% tin / 5% antimony)

2.4 BRAZED JOINTS

- A. Fill Material
 - 1. Cuprous metal to cuprous metal: 15% minimum silver content
 - 2. Cuprous metal to steel: 45% minimum silver content
 - 3. High temperature, high pressure or lab/process piping applications: 15% minimum silver content
 - 4. Joints difficult to access (e.g. closed chases, underground): 15% minimum silver content

2.5 THREADED JOINTS

- A. Thread Sealant
 - 1. Paste type, non-hardening, rated for temperature

2.6 FLANGED JOINTS

- 1. Gaskets, Steam applications
 - a. Spiral wound type
 - b. Stainless steel with flexible graphite filler material

- c. Basis of design:
 - 1) Flexitallic / Flexicarb (gray stripe)
- 2. Bolts
 - a. Hexagonal: ASME B18.2.1
 - b. Temperatures less than 400-degrees-F
 - 1) Carbon steel, ASTM A307 Grade B
 - c. Temperatures 400 – 790-degrees-F
 - 1) Alloy steel, ASTM A193 Grade B7
- 3. Nuts
 - a. Hexagonal: ASME B18.2.2
 - b. Temperatures less than 400-degrees-F
 - 1) Carbon steel, ASTM A194 Grade B
 - a. Temperatures 400 – 790-degrees-F
 - 1) Carbon Steel, ASTM A194 Grade 2H

2.2 WELDED JOINTS

- A. Materials and Methods: In compliance with Weld Procedure Specifications (WPS)
- B. Welding Requirements: In compliance with section below entitled WELDING.

PART 3 – EXECUTION

3.1 SOLDERING

- A. Soldering shall be in conformance with *Copper Development Association - Copper Tube Handbook* including:
 - 1. Selection of solder and flux
 - 2. Measuring and cutting
 - 3. Reaming
 - 4. Application of flux
 - 5. Assembly and support
 - 6. Heating
 - 7. Application of solder
 - 8. Cooling and cleaning
 - 9. Testing
- B. Destructive Testing

Note to Contractor: Given destructive testing requirements specified below, adequate quality control is required to avoid potentially substantial and costly rework on UIS projects. Joints will be destructively tested for quality, not just leak-tightness.

- 1. Destructive testing shall be performed on up to 5% of soldered joints at Contractor's expense. Joints shall be selected by AE or Owner.

2. If joints are found to be in non-compliance with referenced standards, joint shall be repaired or replaced to satisfaction of AE or Owner and up to an additional 10% of joints shall be tested.
3. If additional non-compliant joint or joints are found, joints identified by AE or Owner shall be replaced.

3.2 BRAZING

- A. Brazing shall be in conformance with *Copper Development Association - Copper Tube Handbook* including:
 1. Selection of filler material and flux
 2. Measuring, cutting, reaming
 3. Application of flux
 4. Assembly and support
 5. Applying heat and brazing
 6. Cooling and removing residue
 7. Testing
- B. During brazing, piping shall be purged with oil-free nitrogen.
- C. Joints in following system types shall be brazed:
 1. Laboratory and process gas systems
 2. Systems with pressures in excess of 350-PSIG
 3. Systems with temperatures in excess 450-degrees-C
 4. Underground copper piping systems
 5. Other systems as indicated in project documents
- D. Destructive Testing
 1. Destructive testing shall be performed as identified above for solder joints.

3.3 THREADED JOINTS

- A. Tapered NPT threads shall be properly cut on piping at joints.
- B. Joint sealant shall be applied.
- C. Torque shall be applied as required to properly seat threads.

3.4 FLANGED JOINTS

- A. Flanges shall be properly aligned with minimal application of force.
- B. Gasket shall be properly positioned.
- C. Bolts shall be inserted and anti-seize compound applied.
- D. Bolts shall be torqued to specified value.

3.5 WELDING

- A. Qualifications
 1. Welders and welding procedure specifications (WPS) shall be qualified as set forth in *ASME Boiler and Pressure Vessel Code, Section IX*

a. Welder

- 1) Prior to performing project welds documentation shall be submitted confirming that each welder has passed required procedure test. Welders shall be qualified as required by *ASME-B31.1* or *ASME-B31.9* as applicable.
- 2) Welder qualifications shall be current. If qualification test is more than six months old record of continuity shall be provided indicating welder has performed applicable and approved welding at least every six months since date of qualification test.

B. Weld Inspection and Examination

1. Welds in piping and piping components shall be carefully visually examined in accordance with ASME Standard B31.1 or ASME-B31.9 as applicable.
2. Periodically, as welding progresses, report shall be provided indicating status of project welding quality.

C. Welding Procedure

1. Welding shall comply with applicable requirements of referenced *ASME* and *AWA* Standards.
2. Fittings shall be factory standard fittings. Fabricated fittings not allowed.
3. Backing rings shall not be used with welded joints.
4. Interior of pipe and fittings shall be thoroughly cleaned prior to and after welding/assembly.
5. Welds shall be built up with stringer-bead pass followed by hot pass, followed by cover or filler pass.
6. Valleys at center or edges of welds not allowed. Unsound or unfused metal, cracks, oxidation, blow hoes or non-metallic inclusions not allowed. Imperfections shall be corrected in compliance with referenced standards and to satisfaction of AE and Owner.
7. When hot-tapping, slag, drillings or "cookies" shall be prevented from entering piping system to greatest degree possible. Material that enters piping shall be removed by use of magnet after drilling or cutting is complete.
8. Each weld shall be painted shortly after completion to prevent corrosion.

D. FUSION WELDING – POLYPROPYLENE

- A. PP-R and PP-RCT polypropylene pipe and fittings shall be fusion welded per Manufacturer's instructions.
 1. Joints in piping 4" and smaller shall be heat fusion socket welded.
 2. Joints in piping 6" and larger shall be heat fusion butt welded.

END OF SECTION 232000

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 232113 - HYDRONIC PIPING

PART I - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Pipe and Fittings
 - a. Metallic Pipe and Fittings
 - b. Non-metallic (Polymeric) Pipe and Fittings. Requires Owner approval.
 - 2. Valves
 - a. Shut Off Valves:
 - i. HVAC Grade
 - ii. Industrial Grade
 - b. Globe Valves:
 - i. HVAC Grade
 - ii. Industrial Grade
 - c. Silent Check Valves:
 - i. HVAC Grade
 - ii. Industrial Grade
 - d. Swing Check Valves:
 - i. HVAC Grade
 - e. Manual Balancing Valves
 - f. Pressure Independent Flow Limiting Valves:
 - i. Fixed flow
 - ii. Adjustable flow
 - 3. Differential Pressure Controllers
 - 4. "Coil Pack" Assemblies
 - 5. Vents and Drains

1.2 DEFINITIONS

- A. Hydronic System: Non-potable water-based heat transfer system, excluding steam. Hydronic systems include heating hot water, chilled water, chilled beam and condenser water systems.
- B. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer

name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.

3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.

C. Abbreviations:

1. %: Percent.
2. AHU: Air-handling unit.
3. ANSI: American National Standards Institute.
4. ASME: The American Society of Mechanical Engineers.
5. ASTM: The American Society for Testing of Materials.
6. CWP: Cold working pressure (PSIG).
7. E.g.: Exempli gratia "for example."
8. Etc.: Et cetera "and other similar things"
9. EPDM: Ethylene propylene diene monomer rubber.
10. F: Degrees Fahrenheit.
11. FPS: Feet per second.
12. FT or ' : Feet.
13. GPM: Gallons per minute.
14. HNBR: Hydrogenated nitrile butadiene rubber.
15. HVAC: Heating, Ventilating, and Air-conditioning.
16. HW: Heating hot water.
17. I.e.: Id est "in other words."
18. In or " : Inches.
19. NFPA: National fire protection association.
20. NPT: National pipe thread.
21. PH: Precipitation-hardening
22. PP: Polypropylene piping. Requires Owner approval.
23. PP-R: PP random copolymerized piping. Requires Owner approval.
24. PP-RCT: PP random crystallinity temperature piping. Requires Owner approval.
25. PRV: Pressure regulating valve.
26. PSID: Pounds-per square-inch differential pressure.
27. PSIG: Pounds-per square-inch gauge pressure.
28. PTFE: Polytetrafluoroethylene.
29. P/T: Pressure / temperature.
30. RPTFE: Reinforced PTFE.

31. SDR: Standard dimension ratio.
32. SS: Stainless-steel.
33. SWP: Steam working pressure (PSIG).
34. TFM: Modified PTFE.
35. UIS: The University of Illinois at Springfield.

1.3 QUALITY ASSURANCE

- A. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and installation, operations, and maintenance manuals.

1.4 SUBMITTALS

- A. Pipe and tubing: Type, material, ASTM number, schedule/wall thickness
- B. Pipe certification, indication of domestic manufacture
- C. Fittings: Type, material, ASME number, pressure class
- D. Flanges: Type, material, ASTM number, pressure class
- E. Unions: Type, material, ASTM number, pressure class
- F. Flange gaskets; material, construction, temperature/ pressure rating
- G. Welder Certifications
- H. Polypropylene piping systems
 1. Pressure/leak test documentation as required by Manufacturer to satisfy warranty requirements.
 2. Test documentation shall be submitted to PSC and directly to Manufacturer.
 3. Documentation shall clearly identify Owner, facility and system.

1.5 DISALLOWED PRODUCTS

- A. Roll groove or cut groove joints:
 1. Exceptions: Variance required
 - a. In limited areas where hot work is disallowed by Owner
 - b. For limited repair work
- B. Press-connect joints:
 1. Exceptions (Variance required):
 - a. In limited areas where hot work is disallowed by Owner.
 - b. For limited repair work

Mechanically formed extruded outlets

- C. Piercing valves and fittings
- D. Saddle connections
- E. Welded branch connections
- F. Reducing bushings and flanges
- G. Dielectric unions or fittings:

1. Exception: In cases where a dielectric fitting is deemed necessary such shall be “Clearflow” dielectric nipple. No other manufacturer or product design allowed. Dielectric unions with flexible elastomeric (e.g. rubber, plastic) components not allowed.

H. Flexible hose:

1. Except coil pack assemblies as specified
2. Except final connection to equipment as approved by Owner

I. Nonmetallic (e.g. polypropylene) piping systems:

1. Except as approved by Owner

J. Nonmetallic valves

K. Other non-standard pipe and fittings

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Pipe and tubing shall be transported with ends tightly covered, protected from physical damage. Copper tubing and threaded pipe shall have factory applied end caps maintained in place throughout transportation and storage.
- B. Fittings, valves, specialties and materials shall be transported protected from physical damage and protected from weather.
- C. Large pipe may be stored outdoors on rack or wood blocking with ends tightly covered.
- D. Materials shall be stored indoors protected from temperature, physical damage and exposure to fluids, dust and debris. Containers of solder, brazing and weld consumables, pastes and fluids shall remain sealed until use. Opened containers shall be kept sealed when not in use.

1.7 WARRANTY

- A. Products and installation thereof shall be warranted to be free from defects in material and workmanship for period of one year from date placed into useful service or 18-months from date of delivery, whichever occurs first. Defective product shall be repaired or replaced at no cost to Owner.
- B. Joints shall be warranted to be free from leaks and imperfections for same time period. Defective joint shall be repaired or replaced at no cost to Owner. Impacted piping system shall be manipulated as required to make repair and fluid media shall be brought back to original condition and fill volume at no cost to Owner.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. 125-PSIG, 250-F, Metallic :

1. Size 2” and Smaller - Copper
 - a. Tubing: Copper, ASTM-B88, Type L, Hard Drawn Seamless
 - b. Fittings: Wrought Copper, ASME-B16.22 or Cast Copper Alloy, ASME-B16.18, Solder Joint
 - c. Pipe nipples: Red Brass, ASTM-B-687, Schedule 80, Seamless, NPT
 - d. Unions: Wrought Copper, ASME-B16.22 or cast Copper Alloy, ASME-B16.18, Solder Joint
 - e. Flanges: Cast Bronze, Class 125, ASME-B16.24, Solder Joint

2. Size 2" and Smaller:
 - a. Pipe: Carbon Steel, ASTM-A53 Grade B – Type E or S, Schedule 40
 - b. Fittings: Cast Iron, Class 125, NPT
 - c. Pipe nipples: Carbon steel, ASTM-A53 Grade B, Schedule 80.
 - d. Unions: Cast Iron, Class 250, NPT
3. Size 2-1/2" and Larger:
 - a. Pipe: Carbon Steel, ASTM-A53 Grade B, Type E or S, Schedule 40 or Schedule Standard
 - b. Fittings: Wrought Carbon Steel, ASTM-A234 WPB, Weld Neck
 - c. Flanges: Forged Steel, Class 150, ASTM-A105, ASME/ANSI-B16.5, Weld Neck, Raised Face except where bolted to flat face flange

2.2 SHUT-OFF VALVES – HVAC GRADE

A. Notes:

1. Shut-off valves shall be quarter turn ball or butterfly type. Gate valves are allowed only for direct replacement of existing gate valves.
2. When multiple valve types or "overlapping" sizes are specified for given application, "Contractor's Option" applies.

B. Quarter-Turn Type:

1. Size 2-1/2" and Smaller, Threaded Two-Piece Full-Port Ball Valve:
 - a. 600-CWP, 150-SWP
 - b. 250-F temperature rating
 - c. Rated for 50% glycol solution
 - d. Shut-off class VI, bi-directional.
 - e. Two-piece cast bronze body. Yellow brass not acceptable
 - f. NPT connections
 - g. 316 stainless steel full-port solid tunneled ball
 - h. 316 stainless steel stem and nut
 - i. Blow-out proof stem design
 - j. PTFE seats
 - k. Adjustable stem packing
 - l. Lever handle
 - m. Insulated piping applications: Provide stem extension. Formed metal extension not acceptable.
 - n. Chilled water applications: Provide protective stem extension shield to allow operation with no disturbance to insulation. Provide product equivalent to Nibco / Nibseal
 - o. Basis of Design:
 - 1) Apollo / 77C-140-A
 - 2) Nibco / T585-70-66

- 3) Milwaukee / BA-400S3
2. Size 2-1/2" and Larger, Lug Style Resilient-Seated Butterfly Valve:
 - a. Bi-directional dead-end service at rated pressure
 - b. Bubble-tight shut-off
 - c. Pressure rating:
 - 1) 12" and smaller: 200-PSIG, except Amri / Isora 150-PSIG (for reduced torque)
 - 2) 14" and larger: 150-PSIG
 - d. 250-F temperature rating
 - e. Rated for 50% glycol solution
 - f. Ductile iron lug style body. Cast iron or wafer style body not acceptable
 - g. Industrial paint or epoxy coating
 - h. EPDM seat:
 - p. Aluminum bronze or stainless steel disc
 - q. Two-piece stainless steel shaft
 - r. Upper and lower bearings
 - s. Blow-out proof shaft design
 - t. Manual actuator:
 - 1) Valves 6" and smaller: 10-position lever handle
 - 2) Valves 8" and larger: Geared rotary hand-wheel operator
 - u. Basis of Design:
 - 1) Amri / Isora
 - 2) Cameron / Demco
 - 3) Ebro / Model Z014
 - 4) Pratt / BF Series
 - v. Contractor's option:
 - 1) In lieu of HVAC grade butterfly valves specified above, provide industrial grade high performance butterfly valve as specified below

2.3 SHUT-OFF VALVES – INDUSTRIAL GRADE

A. Quarter-Turn Type:

1. Size 2" and Smaller, Threaded Three-Piece Full-Port Ball Valve:
 - a. Pressure class 600
 - b. 150-PSID shut-off rating
 - c. 250-F temperature rating
 - d. Rated for 50% glycol/water solution
 - e. Leakage class VI, bi-directional
 - f. Carbon steel or stainless steel three-piece body

- g. NPT connections
 - h. Type 316 stainless steel full-port ball and stem
 - i. Blow-out proof stem design
 - j. Reinforced PTFE (RPTFE) or TFM seats
 - k. Live-loaded stem packing
 - l. Manufacturers:
 - 1) Jamesbury
 - 2) Habonim
 - 3) PBM
 - 4) Worcester
2. Size 2-1/2" and Larger, Lug Style High Performance Butterfly Valve:
- a. ANSI Class 150
 - b. Shut-off class VI, bi-directional
 - c. Stainless steel or carbon steel lug-style body
 - d. 316 stainless steel double-offset disc
 - e. Reinforced PTFE (RPFT) seats
 - f. Disc centering feature
 - g. 17-4 PH stainless steel shaft
 - h. Blow-out proof shaft design
 - i. Stainless steel / polymer composite shaft bearings
 - j. Adjustable graphite shaft packing
 - k. Geared rotary hand-wheel operator
 - m. Manufacturers:
 - 1) Jamesbury
 - 2) Cameron W-K-M
 - 3) Xomox

2.4 GLOBE VALVES – HVAC GRADE

- A. Size 2" and Smaller, Threaded Bronze Globe Valve:
- 1. ANSI Class 150
 - 2. Cast bronze body
 - 3. Union bonnet
 - 4. NPT connections
 - 5. Renewable disc
 - 6. Basis of design: Nibco / T-235-Y
- B. Size 2-1/2" and Larger, Flanged Cast Iron Globe Valve:
- 1. ANSI Class 125

2. Cast iron body
3. Bolted bonnet
4. Flanged connections
5. Bronze trim
6. Renewable seat and disc
7. Basis of design: Nibco / F-718-B

2.5 GLOBE VALVES - INDUSTRIAL GRADE

A. Size 2" and Smaller – Threaded Bronze Globe Valve:

1. ANSI Class 300
2. Cast bronze body
3. Union bonnet
4. NPT connections
5. Renewable stainless steel pug and disc
6. Basis of design: Apollo / 128T Series

B. Size 2-1/2" and Larger:

1. ANSI Class 250
2. Cast iron body and cover
3. Bolted bonnet
4. Flanged connections
5. Bronze trim
6. Renewable disc and seat
7. Basis of design: Nibco / F-768-B

2.6 SILENT CHECK VALVES – HVAC GRADE

A. Size 2" and Smaller – Threaded Inline Lift Check:

1. 125-SWP, 400-CWP
2. Cast bronze body
3. NPT connections
4. PTFE plug/disc
5. Stainless steel trim
6. Repairable
7. Basis of design: Apollo / CVB 61-200

B. Size 2-1/2" through 8", Flanged Globe Style Center-Guided:

1. 125-SWP, 200-CWP
2. Cast iron body
3. Flanged or lug style connections
4. Wafer configuration not allowed

5. Renewable disc and seat
 6. 316 SS spring/trim
 7. Basis of design: Keckley / Style CG
- C. Size 10" and Larger, Flanged Spring-Loaded Dual Disc :
1. Class 125 or 150
 2. Flanged or lug-style connections
 3. Water configuration not allowed
 4. Renewable discs and seat
 5. 316 SS spring/trim
 6. Basis of design: Keckley Style DD

2.7 SILENT CHECK VALVES – INDUSTRIAL GRADE

- A. Size 2" and Smaller, Inline Body-Guided:
1. Repairable non-slam spring-loaded design
 2. ANSI class 300
 3. Steel or stainless steel body
 4. NPT connections
 5. 250-F temperature rating
 6. Body-guided disc
 7. Stainless steel trim and disc
 8. Basis of design:
 - a. DFT / model SCV
 - b. Watson McDaniel / WSSCV
- B. Size 2-1/2" and Larger, Inline Center-Guided:
1. Repairable non-slam spring-loaded design
 2. ANSI class 150
 3. Steel or stainless steel body
 4. Wafer or lug style body
 5. 250-F temperature rating
 6. Center-guided disc
 7. Stainless steel trim and disc
 8. Basis of design: DFT / model WLC

2.8 SWING CHECK VALVES – HVAC GRADE

- A. Size 2" and Smaller, Threaded Bronze Swing Check:
1. 150-SWP, 300-CWP
 2. Cast bronze body and threaded cap
 3. NPT connections

4. Renewable bronze disk
 5. Renewable/regrindable bronze seat
 6. Basis of design: Nibco / T473-B
- B. Size 2-1/2" and Larger, Flanged Cast Iron Swing Check:
1. 125-SWP, 200-CWP
 2. Cast iron body and bolted bonnet
 3. Flanged connections
 4. Renewable disc and seat
 6. Basis of design: Nibco / F-918-B

2.9 VENTURI FLOW ELEMENTS

- A. Provide venturi flow element in lieu of balancing valve for flow measurement purposes.
- B. See section by this name in *Section 23 05 19 - Meters and Gauges for HVAC Piping*.

2.10 BALANCING VALVES

- A. Fixed-Orifice Wye-Pattern Globe Type
1. Size 2" and Smaller:
 - a. 300-PSIG at 250-F
 - b. Rated for 50% glycol/water solution
 - c. Forged brass body
 - d. NPT connections
 - e. Multi-turn, calibrated
 - f. Memory stop
 - g. P/T test plugs
 - h. Manufacturers:
 - 1) TA/Victaulic
 - 2) Macon
 - 3) Mepco
 - 4) Wheatley
 - 5) Armstrong
 - 6) IMI Flow Design / Acusetter
 - i. Disallowed products:
 - (a) Nibco
 - (b) Bell and Gossett Circuit Setter
 2. Size 2 1/2" and Larger :
 - a. 250-PSIG at 250-F
 - b. Rated for 50% glycol/water solution
 - c. Cast iron or ductile iron body

- d. Flanged connections
 - e. Multi-turn, calibrated
 - f. Memory stop
 - g. P/T test plugs
 - h. Basis of design: Victaulic-TA / STAF
- 2.11 PRESSURE INDEPENDENT FLOW LIMITING VALVES
- A. Fixed Flow Type:
- 1. Size 2" and Smaller:
 - a. 600-CWP
 - b. 250-F temperature rating
 - c. Rated for 50% glycol solution
 - d. Forged brass construction
 - e. NPT connections
 - f. P/T test plugs
 - g. Stainless steel cartridge and spring
 - h. Integral isolation ball valve
 - i. Integral union
 - j. Integral wye strainer:
 - 1) 20 mesh stainless steel screen
 - 2) Blow-down/drain valve
 - 3) Hose adapter and cap
 - k. Elastomers:
 - (e) Union: Viton O-ring
 - (a) Color coded to prevent confusion with EPDM
 - (f) Balance: EPDM
 - l. Insulated piping applications:
 - 1) Valve stem and P/T port extensions
 - 2) Formed metal valve stem extension not acceptable
 - m. Operating pressure range as determined by application
 - n. Basis of design:
 - 1) Nexus / UltraMatic
 - 2) Griswold / Isolator
 - 3) IMI Flow / Design Autoflow
 - 2. Size 2-1/2" - 3":
 - a. 150-PSIG
 - b. 250-F temperature rating

- c. Rated for 50% glycol solution
 - d. Ductile iron body
 - e. Flanged connections
 - f. P/T test plugs
 - g. Insulated piping applications:
 - 1) Valve stem and P/T test plug extensions
 - 2) Formed metal valve stem extension not acceptable
 - h. Operating pressure range as determined by application
 - i. Basis of Design: Griswold / Uni-Flange or comparable product by the following:
 - 1) IMI Flow Design
 - 2) Pro-hydraulics
- C. Adjustable Flow Type:
- 1. Size 2" and Smaller
 - a. 400-CWP
 - b. 250-F temperature rating
 - c. Rated for 50% glycol solution
 - d. Forged brass construction
 - e. NPT connections
 - f. Multi-turn, calibrated flow rate selector handle with memory stop
 - g. P/T test plugs
 - h. Integral isolation ball valve
 - i. Integral union
 - j. Integral wye strainer:
 - 1) 20-mesh stainless steel screen
 - 2) Blow-down/drain valve
 - 3) Hose adapter and cap
 - k. Union
 - l. Elastomers:
 - 1) Union: Viton O-ring:
 - (a) Color coded to prevent confusion with EPDM
 - 2) Balance: EPDM
 - m. Operating pressure range as determined by application
 - n. Insulated piping applications:
 - 1) Provide valve stem and P/T test plug extensions
 - 2) Formed metal valve stem extension not acceptable

- o. Basis of design:
 - 1) Bell and Gossett / Circuit Sentry Flo-Setter
 - 2) IMI Flow Design / Autoflow/Harmony
- 2. Size 2 1/2" and Larger:
 - a. 150-PSIG
 - b. 250-F temperature rating
 - c. Rated for 50% glycol solution
 - d. Ductile iron body
 - e. Flanged connections
 - f. Multi-turn, calibrated flow rate selector handle with memory stop
 - g. P/T test plugs
 - h. Operating pressure range as determined by application
 - i. Insulated piping applications:
 - 1) Provide valve stem and P/T test plug extensions
 - 2) Formed metal valve stem extension not allowed extension not acceptable.
 - j. Manufacturers:
 - 1) FloCon SH (a Griswold company)
 - 2) IMI Flow Design

2.12 "COIL PACK" MULTI-FUNCTION VALVE ASSEMBLIES

- A. Two-way Type with Strainer:
 - 1. Size 1 1/4" and Smaller (maximum coil pack size):
 - a. 600-CWP
 - b. 250F temperature rating
 - c. Rated for 50% glycol solution
 - d. Forged brass construction
 - e. NPT connections
 - f. P/T test plugs
 - g. Integral isolation ball valves
 - h. Integral wye strainer:
 - 1) 20-mesh stainless steel screen
 - 2) Blow-down/drain valve
 - 3) Hose adapter and cap
 - i. Manual balancing valve:
 - 1) Calibrated multi-turn globe style (preferred)
 - 2) See paragraph 2.2.D *Manual Balancing Valves* for specification
 - 3) Calibrated orifice type allowed

- 4) Memory stop
- 5) P/T test plugs
- j. Adapter/tail-pieces:
 - 1) Union with P/T plug, drain, and/or vent
- k. Air vent:
 - 1) Tool-less type only; "coin vent" or "screwdriver vent" not allowed
 - 2) Provision for horizontal attachment of hose or tubing
- l. Hose (as applicable):
 - 1) Rated 400-PSIG at 250-F.
 - 2) 18" maximum length
 - 3) Stainless steel braid
- m. Elastomers:
 - 1) Unions: Viton O-ring
 - (a) Color coded (to prevent confusion with EPDM)
 - 2) Other elastomers: EPDM
- n. Insulated piping applications: Provide valve stem and P/T plug extensions. Formed metal valve stem extension not acceptable.
- o. Identification tag with model number and GPM
- p. Manufacturers:
 - 3) Nexus
 - 4) Macon
 - 5) Griswold
 - 6) TA/Victaulic
- q. Disallowed products:
 - 1) HCI Terminator
 - 2) Nibco

2.13 VENTS AND DRAINS

A. Air Vents:

1. Vents shall be 1/2" or 3/4" ball valves as specified above in section entitled Shut-Off Valves except valves may be standard port. Vent shall incorporate down-turned discharge pipe with hose adapter and cap.
2. 1/4" ball valves may be used where space is inadequate for 1/2" ball valve (e.g. within cabinet of heat transfer equipment). Hose adapter not required for 1/4" vent.
3. Automatic air vents not allowed unless integral to equipment (e.g. air/dirt separator).

B. Drains:

1. Drain valves shall be 3/4" or 1" full port ball valves as specified above in section entitled Shut-Off Valves. Drain shall incorporate hose adapter and cap.

2. Smaller drain valves may be used when piping is smaller than 3/4". In such cases drain valve shall be same size as pipe. Hose adapter not required for drains smaller than 1/2".
3. "Boiler drains" not allowed.

PART 3 - EXECUTION

3.1 PIPE SIZING

- A. Copper piping shall be sized such that fluid velocity does not exceed 4-FPS under any operating condition.

3.2 PIPE AND FITTINGS

- A. Interior of pipe and fittings shall be thoroughly cleaned prior to assembly.
- B. Piping shall be installed plumb and orthogonal relative to floors and walls.
- C. Piping shall be located and configured to avoid interferences and maintain access to devices and equipment requiring service.
- D. Piping shall not be located above electrical panel boards, switchgear, switchboards or motor control centers and shall comply with requirements of the National Electric Code.
- E. Anchors, expansion joints, swing joints and expansion loops shall be provided as required to provide/control movement.
- F. Horizontal mains shall be pitched up 1" per 40' in direction of flow.
- I. Eccentric fittings shall be used for changes in pipe size in horizontal lines and shall be oriented with top of pipe straight.
- J. Elbows and tees shall be long radius type. Short radius not allowed.
- K. Bull-head tee configuration not allowed.
- L. "Weldolets", "Threadolets" and "Sokolets" may be used for branch connections and instrumentation. Maximum size of branch shall be two pipe sizes smaller than main.
- M. Steel and brass threaded pipe nipples shall be schedule 80.
- N. Unless otherwise indicated, branch lines shall be connected to sides of horizontal mains. Branches shall not be connected to top or bottom of mains.
- O. Where separation of copper and ferrous piping is required brass fittings, bronze fittings or bronze body valves shall be used. If use of dielectric fitting is deemed necessary such shall be "Clearflow" metal nipple with thermoplastic liner. No other manufacturer or design is allowed. Dielectric unions with flexible elastomeric (e.g. rubber, plastic) components not allowed.
- K. At a minimum, manual isolation valves shall be provided:
 1. At branch connections to supply and return mains as indicated on drawings.
 2. At supply and return connecting to each unit, device or piece of equipment.
 3. At inlet and outlet of each control valve or other automated device.
 4. At other locations in piping system as indicated on drawings.
- L. Isolation valves in branch piping shall be located as near connection to mains as practical.
- M. Isolation valves in branch lines serving vents, drains, and instrumentation shall be close-coupled with branch valves located near mains.
- N. At a minimum, unions or flanges shall be provided:
 1. At connections to each unit, device or piece of equipment

2. At specialties such as strainers, expansion tanks, etc.
 3. At equipment or branch side of each manual valve.
 4. At inlet and outlet of each control valve or other automated device.
 5. Where required to facilitate removal of piping sections that interfere with tube pulls or equipment removal.
- O. When connecting raised face steel flanges to flat face cast iron flanges, raised face flange shall be machined flat for proper connection.

3.3 PIPE JOINING

- A. Soldered, brazed, threaded and welded pipe connections shall comply with requirements of *ASME B31.9*.
- B. Any requirement for destructive testing applies.

3.4 VALVES

A. Disc Position:

1. Resilient Seated Butterfly Valve:

- a. Valve shall be installed with disc partially open. Installation with disc in closed position will damage seat

B. Valve Orientation:

1. Ball Valve:

- a. Valve may be installed in any position except with stem oriented vertically downward (i.e. with handle at bottom).
- b. Valve shall be installed such that the direction of flow indication on the valve body and/or product literature, if any, matches the actual direction of fluid flow through the valve.

2. Butterfly Valve:

- a. Valve shall be installed such that the shaft is oriented horizontally. In no case shall the valve be installed such that the shaft is oriented vertically downward (i.e. with the actuator at the bottom).
- b. Valve shall be installed such that the direction of flow indication on the valve body and/or product literature, if any, matches the actual direction of fluid flow through the valve.

3. Check Valves:

a. Swing Check Valves:

- 1) Check valve shall be installed in horizontal or vertical up flow configuration. They shall not be installed in vertical downward flow configuration.

b. Silent Check Valves:

- 1) Check valve shall be installed in vertical up flow configuration only.

B. Valve Insulation:

1. Insulated Piping Applications:

- a. Valves in insulated piping systems shall have the body, flanges, etc., completely insulated. The practice of leaving heating valves and associated unions/flanges un-insulated is not acceptable.

- b. Insulated valves shall be equipped with extended stems and protective shields as required to allow operation without disturbing insulation.
- c. Valves shall be provided with lock-out trim where indicated on the drawings. Extended stems are not required on valves with lock out trim.

3.4 PRESSURE INDEPENDENT FLOW LIMITING VALVES

- A. Fixed Flow Type:
 - 1. Operating pressure range shall be selected prior to shipment.
 - 2. Wye strainer shall be provided upstream of valve if not integral.
 - 3. Flow limiting valve shall not be installed in series with control valve.
- B. Adjustable Flow Type :
 - 1. Operating pressure range shall be selected prior to shipment.
 - 2. Wye strainer shall be provided upstream of valve if not integral.
 - 3. Flow rate shall be adjusted per design and locked in place.
 - 4. Flow limiting valve shall not be installed in series with control valve.

3.5 VENTURI FLOW ELEMENTS

- A. Provide venturi flow element in lieu of balancing valve for flow measurement purposes.
- B. See section by this name in *Section 23 05 19 - Meters and Gauges for HVAC Piping*.

3.6 MANUAL BALANCING VALVES

- A. Balancing valve shall be located in return line near coil/unit served as applicable.
- B. Adequate straight run shall be provided upstream and downstream of valve per manufacturer's recommendations.
- C. Valve size shall be properly selected per manufacturer's recommendations. Proper size is often smaller than pipe size.
- D. Balancing valves shall be used for balancing only. They shall not be used for isolation. A separate valve shall be provided for isolation.

3.7 "COIL PACK" MULTIFUNCTION VALVE ASSEMBLIES

- A. Configuration:
 - A. Coil pack shall be assembled with isolation valves in supply and return piping such that components can be isolated from system piping.
- B. Strainer Assembly:
 - A. Strainer assembly shall be provided with isolation valve, union, blow-down/drain, hose adapter, cap in supply piping near coil inlet.
- C. Hoses (as applicable):
 - A. Hoses shall be connected at coil inlet and outlet.
 - B. Hose length shall be limited to maximum allowed (see above specification).
 - C. Bend radius shall be limited to manufacturer recommendation.
 - D. Piping shall be supported independently of unit.

- D. Adapters:
 - A. Union/adaptor shall be installed in return piping near coil outlet.
 - B. Control valve shall be installed (specified elsewhere).
 - C. Union/adaptor and isolation valve shall be provided in return piping downstream of control valve.
- E. Vents and Drains:
 - A. Air vent shall be provided at high point of coil outlet.
 - B. Drain shall be provided at low point of coil inlet.
- F. P/T plugs:
 - A. P/T plugs shall be provided at coil inlet and outlet for pressure and temperature measurement.

3.8 VENTS AND DRAINS

- A. Vents:
 - 1. Air vents shall be provided at highpoints in system where air may collect. Additionally, vents shall be provided at locations shown on drawings. When possible, vents shall be installed at locations where flow turns downward.
 - 2. Air vents shall be “close coupled” to pipe and shall incorporate down-turned discharge pipe with hose adapter and cap. Exception: Hose adapter and cap not required for 1/4” vent valves. Hose adapter and cap not required for vents integral to coil pack assemblies. Down-turned discharge still required.
- B. Drains:
 - 1. Drain valves shall be provided at low points in piping system where water may gather and where debris may collect to allow full drainage of fluid from system. Additionally, drains shall be provided at locations shown on drawings. When possible, drains shall be installed at locations where flow turns upward.
 - 2. Drains shall be “close coupled” to pipe and shall incorporate discharge pipe with hose adapter and cap. Exception for small piping addressed above in paragraph entitled Drains.
- C. Cooling Coil Vent and Drain:
 - 1. Brass pipe nipples shall be provided at cooling coil vent and drain connections. Piping between coil and valve shall be schedule 80 brass.
- D. Cooling Coil Condensate Drains:
 - 1. Dedicated drain line shall be provided for each condensate drain connection.
 - 2. Trap shall be provided in each drain line of sufficient depth to prevent conditioned air from moving through piping. Trap shall be constructed with plugged or capped tee for cleanout purposes.
 - 3. Drain piping shall be extended to approved drain location, pitched downward 1/4” per foot and terminated in code compliant manner.

3.8 INSTRUMENTATION

- A. Instrumentation (e.g. pressure gauge manifold, pressure transmitter) shall be provided as indicated on drawings.
- B. Instrumentation piping from isolation valve to instrument(s) shall be 1/2” copper or stainless steel tubing.

3.9 PRESSURE TESTING

- A. Hydrostatic leak test shall be performed in presence of Owner's representative. 72-hour advance notification shall be provided.
- B. Piping system shall be uninsulated at time test is performed.
- C. System shall be filled with clean water and air shall be vented from piping and devices.
- D. Pressure test may be made of isolated portions of system to facilitate general progress of installation. Any revisions made in piping systems require retest of affected portions of piping systems.
- E. Valves in test segment shall be opened including isolation valves for devices and instrumentation rated for test pressure.
- F. Expansion tank isolation valve shall be closed.
- G. Relief valves shall be temporarily plugged or otherwise disabled as appropriate.
- H. Vessels, components and instrumentation not rated for test pressure or vulnerable to damage shall be isolated.
- I. System shall be hydrostatically tested to 1.5-times maximum system operating pressure, 100-PSIG or pressure relief valve setting, whichever is greatest.
- J. Test gauge shall be used. At a minimum, gauge shall comply with requirements in *Section 23 05 19 – Meters and Gauges for HVAC Piping*.
 - 1. Gauge shall be ANSI Grade AA (2A), 1/2% full scale accuracy minimum.
- K. Test pressure shall be held for 2-hours minimum with no drop in gage pressure. Piping, joints and connections shall be inspected for leakage.
- L. After leaks are eliminated test shall be repeated until system is demonstrated to be leak tight to satisfaction of Owner.
- M. Relief valves shall be reinstalled and valves and components restored to operating position/configuration.
- N. Components not hydrostatically tested shall be protected by relief valve during system operation.

3.10 PREOPERATIONAL CLEANING

- A. Preoperational cleaning shall be accomplished in compliance with *Section 23 25 00 – Water Treatment for Hydronic Systems*

3.11 CHEMICAL TREATMENT

- A. System chemical treatment shall be accomplished in compliance with *Section 23 25 00 – Water Treatment for Hydronic Systems*.

END OF SECTION **232113**

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 232116 - HYDRONIC SPECIALTIES

PART I – GENERAL

1.1 SECTION INCLUDES

- A. Y-Pattern Pipeline Strainers
- B. Basket Strainers
- C. Pump Suction Diffusers
- D. Flexible Pipe Connectors
- E. Safety Relief Valves
- F. Air/Dirt Separators
- G. Expansion Tanks
- H. Hydronic Fill Units

Note: Specifications for Bag Type Bypass Filters provided in *Section 23 25 10 – Fluid Filtration*.

1.2 DEFINITIONS

- A. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non-basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
 - 3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.

1.3 QUALITY ASSURANCE

- A. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

1.4 SUBMITTALS

- A. Strainers and suction diffusers: Type, materials of construction, temperature/pressure rating, strainer screen mesh size.
- B. Flexible pipe connectors: Type, materials of construction, temperature/pressure rating, size/length, allowable offset.
- C. Safety relief valves: Type, design, materials of construction, temperature/pressure rating, size, capacity.
- D. Air/dirt separators: Type/design, features, materials of construction, temperature/pressure rating, performance.

- E. Expansion tanks: Type, materials of construction, temperature/pressure rating, acceptance volume.
- F. Hydronic fill unit:
 - 1. Full unit description including accessories
 - 2. Dimensional data, capacities, materials of construction, shipping weight
 - 3. Detailed pump, motor and control panel componentry
 - 4. Pump performance curve with design operating point indicated
 - 5. Motor characteristics as indicated in schedule
 - a. Phase, voltage, full load amps, efficiency, frequency (Hz.)
 - 6. Wiring diagram
 - 7. Piping diagram
 - 8. Operation and maintenance manual

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING.

- A. Materials and equipment shall be protected from physical damage and weather during transport.
- B. Materials and equipment shall be stored indoors protected from physical damage and exposure to dust and debris.
- C. Materials and equipment shall be protected from physical damage and exposure to dust and debris during construction.

1.6 WARRANTY

- A. Products shall be warranted to be free from defects in material and workmanship for period of one year from date of startup or 18 months from date of delivery, whichever occurs first. Defective product shall be repaired or replaced at no cost to Owner.
- B. Assembled units including hydronic fill unit shall be warranted by manufacturer to be free from defects in material and workmanship for period of one year from date of startup or 18 months from date of delivery, whichever occurs first. Manufacturer shall repair or replace unit at no cost to Owner.
- C. Air/dirt separator shall be warranted by manufacturer to provide specified performance for period of one year from date of startup. Manufacturer shall adjust, repair or replace unit at no cost to Owner.

PART 2 - PRODUCTS

2.1 VENTURI FLOW ELEMENTS

- A. Venturi flow elements shall comply with requirements listed in *Section 23 05 19 - Meters and Gauges for HVAC Piping*

2.2 Y-PATTERN PIPELINE STRAINERS

- A. Size 2" and Smaller, Threaded Bronze Y-pattern Strainer
 - 1. 150 SWP, 200 CWP
 - 2. Cast bronze body
 - 3. 2" and smaller: NPT connections
 - 4. Threaded blow-off connection
 - 5. 20 mesh stainless steel screen

- B. Size 2" and Smaller, Flanged Cast Iron Y-Pattern
 1. 250 SWP, 400 CWP, Cast Iron
 2. Cast iron body
 3. NPT connections
 4. Blow-off connection
 5. Threaded blow-off connection
 6. 20 mesh stainless steel screen
- C. Size 2 ½" and Larger, Flanged Cast Iron Y-Pattern
 1. 125 SWP, 200 CWP
 2. Cast iron body
 3. Flanged connections
 4. Threaded blow-off connection
 5. Size 2 ½" through 4": 1/16" perforated stainless steel screen
 6. Size 6" and larger: 1/16" perforated stainless steel screen
- D. Size 2½" and Larger, Flanged Cast Steel Y-Pattern Strainer
 1. Pressure class 150
 2. Cast steel body
 3. Flanged connections
 4. Threaded blow-off connection
 5. Size 2 ½" through 4": 1/16" perforated stainless steel screen
 6. Size 6" and larger: 1/16" perforated stainless steel screen

2.3 BASKET STRAINERS

- A. Size 2" and Smaller, Threaded Bronze Basket Strainer
 1. 250 SWP, 400 CWP
 2. Cast iron body
 3. Bolted cover
 4. Threaded drain with plug
 5. NPT connections
 6. Threaded blow-off connection
 7. 20 mesh stainless steel screen
- B. Size 2 ½" and Larger, Flanged Cast Iron Basket Strainer
 1. 125 SWP, 200 CWP
 2. Cast Iron body
 3. Flanged connections
 4. Threaded blow-off connection
 5. Size 2 ½" through 4": 1/16" perforated stainless steel screen

6. Size 6" and larger: 1/16" perforated stainless steel screen
- C. Size 2½" and Larger, Flanged Cast Steel Basket Strainer
 1. Pressure class 150
 2. Cast steel body
 3. Flanged connections
 4. Threaded blow-off connection
 5. Size 2 ½" through 4": 1/16" perforated stainless steel screen
 6. Size 6" and larger: 1/16" perforated stainless steel screen

2.4 PUMP SUCTION DIFFUSERS

- A. Angle Pattern, Rear Pull-Out
 1. Cast iron body
 2. 175 PSIG working pressure
 3. Temperature rating: 250F
 4. Connections
 - a. Size 2" and smaller: NPT
 - b. Size 2 ½" and larger: Flanged
 5. Full length straightening vanes
 6. Combination strainer-diffuser
 - a. Size 2" and smaller: 20 mesh stainless steel screen
 - b. Size 2 ½" through 4": 1/16 perforated stainless steel screen
 - c. Size 6" and larger: 1/8" perforated stainless steel screen
 7. Removable access cover
 8. Gauge tapings
 9. Adjustable support foot
 10. Disposable startup strainer, fine mesh
 11. Manufacturers: Bell & Gossett, Armstrong, Wheatley

2.5 FLEXIBLE PIPE CONNECTORS

- A. Corrugated braided type connector
 1. Stainless steel inner bellows
 2. Stainless steel braid, single or double braid as required for pressure rating
 3. 200 PSIG working pressure minimum
 4. Connections
 - a. NPT or flanged (flat face) to match pump connections
 5. Length: As required to provide adequate flexibility per manufacturers recommendations
 6. Basis of design: US Hose / USBX or comparable product by one of the following:

- a. Hyspan
- b. Engineered Flexible Products
- c. Metraflex

2.6 SAFETY RELIEF VALVES

- A. Diaphragm and spring type
 1. Bronze body, side outlet
 2. Lifting lever
 3. Brass seat
 4. EPDM diaphragm
 5. Temperature rating: 250F
 8. Rated for 50% glycol solution
 9. ASME certified and labeled
 10. Pressure and heat capacity shall comply with ASME Pressure Vessel Code
 11. BTU rating in excess of maximum heat input
 12. Pressure setting as indicated on drawings or in schedule

2.7 AIR/DIRT SEPARATORS

- A. Coated steel housing
 1. Dimensions established by basis of design product
 2. Pressure rating: 150 PSIG
 3. Temperature rating: 250 degrees F.
 4. Two-piece flanged housing with bottom blow-down connection
 5. Straight-through inlet-outlet design
 6. Pipe connections
 - a. 2" and smaller: NPT
 - b. 2 ½" and larger: Flanged
- B. Engineered coalescing medium
 1. Vertical, cylindrical configuration
 - a. Copper core tubes with continuous wound copper wire medium permanently affixed
 - b. Type 316 stainless steel coalescing elements acceptable if documented and guaranteed on submittal data
 - c. Media shall fill entire vessel
 - d. Perforated steel shapes or tubes, coiled screen or loosely filled rings not acceptable
- C. Proper function
 1. Not reliant upon following:
 - a. Fluid velocity
 - b. Centrifugal action

- c. Pressure change
- D. Appurtenances
 - 1. Skim valve
 - 2. High capacity automatic air vent
- E. Performance
 - 1. Air elimination
 - a. 100% free and entrained air removal
 - b. 99% dissolved air removal
 - 2. Particulate removal
 - a. 80% removal of 30 micron particulates within 100 passes
 - b. Final particulate removal to 5 micron
- F. Basis of Design: Spirotherm / Spirovent

2.8 AUTOMATIC AIR VENTS

- A. Dry vent type
 - 1. Rated 150 PSIG at 250F degrees
 - 2. Brass, stainless steel, non-ferrous materials of construction
 - 3. Viton seat
 - 4. ½" NPT inlet and outlet connections
 - 5. 20 year limited warranty
 - 6. Basis of Design: Spirotherm / Spirotop

2.9 EXPANSION TANKS

- A. Replaceable bladder type, air charged
 - 1. Floor mounted
 - 2. Welded steel shell, painted
 - 3. Full acceptance volume
 - 4. ASME rated, stamped
 - 5. 125 PSIG working pressure
 - 6. Flanged bladder access opening
 - 7. NPT pipe and drain connections
 - 8. Heavy duty butyl rubber bladder
 - 9. Operating temperature: 240F
 - 10. Rated for 50% glycol solution
 - 11. Schrader air charging valve
 - 12. Manufacturers:
 - a. Bell and Gossett
 - b. Wessels

- c. Armstrong
- d. Amtrol
- e. TACO

2.10 HYDRONIC FILL UNITS, PORTABLE

- A. Factory packaged unit
 - 1. Readily portable with standard hand truck
 - 2. Non-metallic cabinet; completely enclosed
 - 3. Steel structural base frame with corrosion resistant coating
 - 4. Free standing floor supported, unanchored
 - 5. Non-metallic mixing tank
 - 6. Integral air gap compliant with Illinois Plumbing Code
 - 7. Peripheral/regenerative turbine pump
 - 8. Pump suction strainer
 - 9. Suction and discharge isolation valves
 - 10. 120V single phase, 60 Hz
 - 11. Electrical extension cord for connection to wall outlet
 - 12. Packaged controls with low water cut-out
 - 13. Suitable for use with 100% glycol
 - 14. Pump fill pressure: 65 PSIG min.
 - 15. Tank capacity: 40 gallon min.
 - 16. Weight: 200 lb. max.
 - 17. Basis of Design: Armstrong Model GLA

PART 3 – EXECUTION

3.1 VENTURI FLOW ELEMENTS

- A. Installation of venturi flow elements shall comply with requirements listed in *Section 23 05 19 - Meters and Gauges for HVAC Piping*.

3.2 STRAINERS

- A. Y-pattern strainer shall be provided upstream of each control valve and at other locations shown on drawings.
- B. Full port ball valve with nipple and cap shall be provided at blow-off connection.
- C. Y-pattern and basket strainers shall be installed in horizontal piping. Y-pattern strainer may also be installed in vertical piping with downward flow.

3.3 PUMP SUCTION DIFFUSERS

- A. Support foot shall be installed and adjusted prior to attaching piping.
- B. Startup screen shall be removed and temporarily attached to pump/piping for later inspection

3.4 FLEXIBLE PIPE CONNECTORS

- A. Pump installation shall be complete. Piping shall be in final position, fully supported and properly aligned with pump connections.
- B. Flexible connector shall be installed “straight” and at “neutral” length. Flexible connector shall not be used to accommodate piping misalignment. At a maximum, flexible connector offset, bend radius and length shall not exceed factory recommended limitations.

3.5 SAFETY RELIEF VALVES

- A. Relief valves shall be provided at each location required by Code and at other locations shown on drawings.
- B. Relief valve capacity and pressure setting shall be as specified, shown on drawings and/or indicated in schedule.
- C. At a minimum, relief valve capacity and pressure setting shall be in compliance with ASME Pressure Vessel Code.
- D. Full size discharge piping shall be extended from relief valve outlet to floor.

3.6 AIR/DIRT SEPARATORS

- A. One air/dirt separator shall be provided for each closed loop hydronic system.
- B. For hot water heating applications, air/dirt separator shall be installed in-line between hot water heat exchanger (hot water convertor) and pump suction connection. Blow-down piping shall connect to system immediately upstream of bypass bag filter.
- C. For chilled water cooling applications air/dirt separator shall be installed in return main upstream of chiller (not applicable to systems served by central chilled water system).
- D. Air/dirt separator shall be supported indirectly via hangers supporting adjacent piping.
- E. Full size piping shall be provided from bottom blow-down valve to floor drain or as shown on drawings. Pipe union or flanged connection shall be provided near valve.

3.7 AUTOMATIC AIR VENTS

- A. Automatic air vents shall be used for initial system filling and startup only.
- B. ½” ball valve with NPT connections shall be provided between hydronic system connection and air vent.
 - 1. Valve shall satisfy specifications provided in 23 21 13 – *Hydronic Piping*.
- C. Copper tubing shall be connected to vent outlet and extended to drain.

3.8 EXPANSION TANKS

- A. Reinforced concrete curb shall be provided, 4” minimum height. Curb shall be firmly anchored into concrete floor. Tank shall be firmly anchored to curb.
- B. Tank piping and instrumentation shall comply with drawings.
- C. Air charge shall be adjusted as follows:
 - 1. Ensure system fluid is room temperature.
 - 2. Ensure all air is vented from system.
 - 3. Close valve between expansion tank and system.
 - 4. Open (to atmosphere) vent/drain valve at expansion tank.

5. Adjust air pressure to design pressure indicated on drawings or in schedule. If not provided, determine as follows:
 - a. Full height of system above tank plus 10-20 ft., (convert to PSIG).
6. Close drain/vent valve at tank.
7. Open valve between expansion tank and system.

3.9 GLYCOL HYDRONIC FILL UNITS

- A. One hydronic fill unit shall be provided for each project that includes one or more closed loop glycol hydronic systems.
- B. Base curb not required. Unit shall not be anchored.
- C. Fill unit shall initially be located near expansion tank for each hydronic system and connected to system fill connection with contractor grade reinforced rubber hose. Standard 3/4" hose connections shall be provided on each end of hose.
- D. Isolation valve shall be kept in closed position while unit is not in operation.
- E. Glycol solution shall be completely flushed from unit after each use.
- F. Unit shall be stored in area separate from system fill connection as directed by Owner.

END OF SECTION 232016

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 232123 - HYDRONIC PUMPS

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Single-stage Centrifugal Pumps
 - 1. In-line Close-coupled
 - 2. Base-mounted End Suction
 - 3. Horizontal Split Case
 - 4. Pump Seals

1.2 QUALITY ASSURANCE

- A. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

1.3 SUBMITTALS

- A. General information
 - 1. Manufacturer, type, full unit description
 - 2. Suction, discharge connection, impeller size
 - 3. Dimensional data, materials of construction, shipping weight
 - 4. Detailed sectional drawings of pump, seals, bearing assembly
 - 5. Pressure, temperature rating
- B. Performance Information
 - 1. Capacity (GPM), head (ft.), NPSHR, efficiency (%)
 - 2. Pump performance curve with design operating point identified
 - 3. Series of Curves - indicating relationship of CFM, SP, RPM, % efficiency and BHP for variable speed applications
- C. Seals
 - 1. Manufacturer, type, description
 - 2. Face materials, elastomers
- D. Motor
 - 1. Manufacturer, enclosure type, frame size, nominal efficiency (%)
 - 2. Horsepower (HP), phase (Ph.), rotational speed (RPM),
 - 3. Voltage (V), full load amperage (FLA), frequency (Hz),
 - 4. Service Factor (SF)
- E. Miscellaneous
 - 1. Wiring diagram
 - 2. Options, accessories information
 - 3. Vibration Isolator Information (if applicable)
 - 4. Installation and operation manual

5. Certified factory test report (if applicable)

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Pump assembly shall be protected from physical damage and weather during transport.
- B. Pump assembly shall be stored indoors protected from physical damage and exposure to dust and debris.
- C. Pump assembly shall be protected from physical damage and exposure to dust and debris during construction.

1.5 MANUFACTURER'S SITE SERVICES

- A. For double suction pumps, manufacturers factory trained service technician shall provide pump start-up services.
 1. Start-up services shall be as indicated in section entitled *STARTUP* in PART 3 of these specifications.
 2. Signed and dated start-up report and warranty certificate shall be provided to AE.
 3. Start-up report shall provide pertinent information confirming that all requirements of contract documents have been satisfied, including specified and/or scheduled performance requirements.
 4. Start-up report shall provide confirmation that water quality is acceptable for use with specified pump seals, as installed.

1.6 WARRANTY

- A. Pump assembly, including motor, shall be warranted to be free from defects in material and workmanship and to perform as specified for period of one year from date of startup or 18 months from date of delivery, whichever occurs first. Defective product shall be repaired or replaced at no cost to Owner.

PART 2 – PRODUCTS

2.1 CENTRIFUGAL PUMPS

- A. Approved for UIS projects
 1. In-line, close coupled, ≤ 2 HP
 2. Base mounted, end suction, ≤ 6 " suction connection
 3. Double suction, horizontal split case, ≥ 8 " suction connection
- B. Disallowed for UIS projects
 1. Close-coupled base mounted (e.g. Bell and Gossett Series 1531)
 2. Double suction, vertical (radial) split case (e.g. Bell and Gossett VSC, VSCS)

2.2 IN-LINE CENTRIFUGAL PUMPS, CLOSE COUPLED

- A. Size
 1. 2 HP and smaller
- B. Design
 1. In-line, close-coupled
 2. Pipeline mounted, supported by piping only

3. Common inlet-outlet center line
 4. NPT or flanged connections
 5. "Back pull-out"
 - a. Serviceable without disturbing pipe connections
- C. Performance
1. As indicated in schedule
 2. Pump shall be selected as close as possible to best efficiency range
- D. Volute
1. Cast Iron
 2. 175 PSIG working pressure
 3. Inlet straitening vane(s)
 4. Tapped and plugged suction, discharge, vent and drain openings
 5. Renewable bronze casing wear ring
- E. Impeller
1. Bronze, enclosed
 2. Mounted directly on motor shaft
 3. Keyed and locked to shaft
 4. Hydraulically and dynamically balanced
- F. Shaft
1. High strength carbon steel or stainless steel
 2. Bronze or stainless steel shaft sleeve
- G. Seal
1. See section below entitled *PUMP SEALS, MECHANICAL* for requirements
 2. Rated 225F continuous operation
- H. Motor
1. 2 HP maximum
 2. Characteristics as indicated in schedule
 - a. Phase, voltage, full load amps, efficiency, frequency (Hz.)
 - b. 1750 RPM maximum
 3. 3 phase motors shall have VFDs provided by Electrical Contractor. Coordination shall be provided.
- I. Basis of design
1. Bell and Gossett Series 90 (Series 60 flexible coupled not allowed)
- J. Approved Manufacturers
1. Bell and Gossett
 2. Aurora

3. Armstrong

2.3 IN-LINE CENTRIFUGAL PUMPS, CLOSE COUPLED, STAINLESS STEEL

- A. Pump shall satisfy all requirements of section entitled *IN-LINE CENTRIFUGAL PUMPS, CLOSE COUPLED* with following exceptions:
 - 1. Following components shall be Type 316 stainless steel
 - a. Volute
 - b. Impeller
 - c. Wear ring
 - d. Seal housing
 - e. Shaft sleeve

2.4 BASE-MOUNTED END-SUCTION CENTRIFUGAL PUMPS

- A. Size
 - 1. 6" suction connection and smaller
- B. Design
 - 1. Base-mounted, end suction, flexible coupled
 - 2. "Back pull-out" with drop-out spacer coupling
 - 3. Impellor and bearing assembly removable without...
 - a. disturbing piping
 - b. removing impeller from shaft
 - c. moving motor
 - d. shaft realignment
- C. Performance
 - 1. As indicated in schedule
 - 2. Pump shall be selected as close as possible to best efficiency point
- D. Vibration
 - 1. 0.15 in./sec. maximum
- E. Volute
 - 1. Cast Iron
 - 2. 175 PSIG working pressure
 - 3. Integral volute "support foot"
 - a. Provide full support of weight of piping
 - (a) Allow removal of rotating assembly without volute movement
 - (b) Eliminate need for realignment
 - 4. Tapped and plugged suction, discharge, vent and drain openings
 - 5. Renewable bronze casing wear ring

- F. Impeller
 - 1. Bronze or stainless steel, enclosed
 - 2. Keyed and locked to shaft
 - 3. Hydraulically and dynamically balanced
- G. Shaft
 - 1. High strength carbon steel
 - 2. Replaceable bronze or stainless steel shaft sleeve
- H. Seal
 - 1. See section below entitled *PUMP SEALS, MECHANICAL* for requirements.
 - 2. Recirculation / flush lines and appurtenances shall be provided as specified therein.
 - 3. Seal shall be rated 250F continuous operation.
- I. Drip capture
 - 1. Drip capture feature or stainless steel drip pan with NPT connection
- J. Bearing assembly
 - 1. Cast iron housing
 - 2. Easily separable from volute
 - 3. Greasable sealed antifriction ball or roller bearings
 - 4. OSHA approved coupling guard
- K. Motor
 - 1. Characteristics as indicated in schedule
 - a. RPM, phase, voltage, full load amps, efficiency, frequency (Hz.)
 - b. 1,750 RPM maximum
 - 2. 3 phase motors shall have VFDs provided by Electrical Contractor. Coordination shall be provided.
- L. Frame/base plate
 - 1. Channel steel, fully enclosed sides
 - 2. Fully groutable through top access
 - 3. Motor positioning rails
 - 4. Completely rigid
- M. Approved Manufacturers
 - 1. Bell and Gossett
 - 2. Armstrong
 - 3. Aurora

2.5 BASE-MOUNTED END-SUCTION CENTRIFUGAL PUMPS, STAINLESS STEEL

- A. Pump shall satisfy all requirements of section entitled *BASE-MOUNTED END-SUCTION CENTRIFUGAL PUMPS* with following exceptions:

1. Following components shall be Type 316 stainless steel
 - a. Volute
 - b. Impeller
 - c. Wear ring
 - d. Seal housing
 - e. Shaft sleeve

2.6 DOUBLE-SUCTION HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

- A. Size
 1. 8" suction connection and larger
- B. Design
 1. Base-mounted
 2. Double suction
 3. Horizontal split case
 4. Flexible coupled
- C. Performance
 1. As indicated in schedule
 2. Pump shall be selected as close as possible to best efficiency point
- D. Vibration
 1. 0.15 in./sec. maximum
- E. Volute
 1. Cast iron, 175 PSIG working pressure
 2. Upper casing removable without disturbing piping
 - a. Jack screws, alignment dowels
 - b. Eye bolt or lifting lugs
 3. Lower casing with integrally cast flanges, bearing supports, support feet
 4. Tapped and plugged suction, discharge, vent and drain openings
 5. Renewable bronze casing wear ring
- F. Frame/base plate
 1. Common base plate for pump and motor
 2. Structural steel, completely rigid, fully enclosed sides
 3. Fully groutable through top access
 4. Threaded jack screws for motor positioning
- G. Impeller
 1. Bronze, enclosed
 2. Keyed and locked to shaft
 3. Hydraulically and dynamically balanced

4. Renewable bronze impellor wear ring
- H. Shaft
1. High strength carbon steel
 2. Replaceable bronze shaft sleeve
- I. Seals
1. See section below entitled *PUMP SEALS, MECHANICAL* for requirements.
 2. Recirculation / flush lines and appurtenances shall be provided as specified therein.
- J. Drip capture
1. Drip capture feature or stainless steel drip pan with NPT connection
- K. Bearing assemblies
1. Cast iron housing/retainer
 2. Easily separable from volute
 3. Greasable sealed antifriction ball or roller bearings
 4. Rated L-10 100,000 hr. service life
 5. Water slinger
- L. Coupling
1. Flexible, drop out spacer type allowing pump servicing without repositioning motor
 2. OSHA approved coupling guard
- M. Motor
1. Characteristics as indicated in schedule
 - a. RPM, phase, voltage, full load amps, efficiency, frequency (Hz.)
 - b. 1,750 RPM maximum
 2. Motor shall have VFD provided by Electrical Contractor. Coordination shall be provided.
- N. Approved Manufacturers
1. Flowserve
 2. Goulds
 3. Peerless, if approved by AE and Owner
- 2.7 PUMP SEALS, MECHANICAL
- A. Close Coupled In-Line Pumps (≤ 2 HP)
1. Component seal, rotary design
 - a. Carbon / ceramic or carbon/silicon carbide seal faces
 - b. Cup-mounted seals
 - c. 316 SS, Hastelloy seat springs
- B. Vertical Split Coupled In-line Pumps (≥ 3 HP)
1. ≤ 10 HP: Component seals, rotary design
 - a. Carbon / ceramic seal faces

- b. Unspecified O-Ring material
- c. 316 SS, Hastelloy seat springs
- d. Recirculation / clean water flush lines not required for standard applications
- 2. ≥ 15 HP: Balanced cartridge seal, stationary design
 - a. Carbon / silicon carbide seal faces
 - b. Viton O-Rings
 - c. 316 SS, Hastelloy seat springs
 - d. Recirculation / flush lines shall be provided as specified for double suction pumps
- C. Close Coupled Base-mounted Pumps (Not allowed by UIUC)
- D. End Suction Pumps (≤ 6 " suction connection size)
 - 1. ≤ 10 HP: Component seal, rotary design
 - a. Cup-mounted seals
 - b. 316 SS, Hastelloy seat springs
 - c. Recirculation / clean water flush lines not required for standard applications
 - 2. ≥ 15 HP: Balanced cartridge seal, stationary design
 - a. Viton cup-mounted seals
 - b. 316 SS, Hastelloy seat springs
 - 1) Recirculation / flush lines shall be provided as specified for double suction pumps
- E. Double Suction Pumps (≥ 8 " suction connection size)
 - 1. Balanced cartridge seals, stationary design. Component seals not allowed.
 - a. Carbon / silicon carbide seal faces
 - b. Viton O-Rings
 - c. 316 SS, Hastelloy seat springs
 - d. Approved Manufacturer
 - 1) John Crane #3740 split seal
 - e. Clean water systems (e.g. chilled water)
 - 1) Recirculation lines (connection to top of volute not allowed)
 - (a) In-line filter housing with 5 micron replaceable cartridge, each seal
 - (b) Rotameter, each seal
 - (c) Flush water throttling device, each seal
 - i. Adjusted to 5-10 GPH each
 - f. Dirty water systems (e.g. cooling tower water)
 - 1) Clean water (i.e. domestic water) flush lines
 - (a) In-line filter housing with 5 micron replaceable cartridge, each seal
 - (b) Rotameter, each seal
 - (c) Flush water throttling device, each seal

- i. Adjusted to 5-10 GPH each
 - (d) Close-tolerance throat bushing, each seal
 - i. Provided when limitation of flow into closed loop system is required
 - ii. Adjusted to 15 FPS velocity through annular space
 - (e) Solenoid valve (for shut off of domestic water when pump is off)
- F. Steam Condensate Pumps
 - 1. Component seal, rotary design
 - a. Carbon / silicon carbide seal faces
 - b. Aflas or Viton O-Rings
 - c. Discharge flush line

PART 3 - EXECUTION

3.1 INSTALLATION

- A. In-line pumps
 - 1. In-line pumps shall be rigidly connected to and supported by adjacent piping. Pipe hanger shall be provided each side of pump.
 - 2. Pump shall be located and oriented to provide adequate access for servicing.
 - 3. Where pump and pipe sizes are different, concentric reducer shall be provided at pump discharge connection and eccentric reducer at pump suction connection.
 - a. Eccentric reducer shall be oriented with top of pipe level.
- B. Base-mounted pumps, fixed ("hard-mounted")
 - 1. Concrete curb shall be provided.
 - a. Curb shall be 2.5 times weight of pump assembly, minimum.
 - b. Curb shall be 4" thick, minimum.
 - c. Curb shall extend 6" beyond pump frame on all sides, minimum.
 - d. Curb shall be anchored into concrete floor.
 - 2. Pump base shall be rigidly anchored to curb, leveled and fully grouted.
 - 3. Piping shall be rigidly attached to pump suction and discharge connections.
 - a. Piping shall be independently supported to prevent loading on pump volute.
- C. Base-mounted pumps with spring supported inertia base
 - 1. Concrete curb shall be provided.
 - a. Same requirements as *concrete curb* above
 - 2. Concrete inertia base and spring supports shall be provided.
 - a. Inertia base shall be steel construction with welded-in reinforcing bars.
 - b. Inertia base dimensions, weight and spring design shall be sized by vibration isolator manufacturer.
 - c. Inertia base shall be filled with concrete and leveled.

- d. Pump base shall be rigidly anchored to inertia base, leveled and fully grouted.
3. Flexible pipe connectors shall be provided at pump suction and discharge connections.
 - a. Connected piping shall be supported independently to prevent loading on flexible connectors and pump volute.
 - 1) Flexible connectors shall be as recommended by vibration isolator manufacturer and as specified elsewhere in project documents.

G. All base-mounted pumps

1. Length of straight pipe shall be provided at pump suction connection. Straight pipe shall be 5-10 pipe diameters in length. Pipeline strainer shall be provided upstream of straight pipe as indicated on drawings.
2. For end suction pumps, suction diffuser may be used in lieu of strainer and straight pipe at pump suction connection only if indicated on project drawings.
 - a. Adjustable support leg shall be provided under suction diffuser as indicated in manufacturer's IOM.
3. Length of pipe, 5 pipe diameters minimum, shall be provided at pump discharge prior to first valve or device.

Where pump and pipe sizes are different, eccentric reducer shall be provided at pump suction connection and concentric reducer at pump discharge connection.

- a. Eccentric reducer shall be oriented with top of pipe level.
4. Flat face pipe flanges on pipe or flexible connectors shall be mated with flat face pump flanges.
5. After pipe connection is complete pump and motor shall be aligned using laser level procedures.
 - a. After alignment is complete pump shall be pinned to motor base, unless directed otherwise by AE.
 - b. Alignment report shall be provided to AE.
6. Pressure gauge, manifold and associated valves shall be provided as indicated on drawings.
7. Seal recirculation/flush lines shall be provided if/as specified.

H. Double-suction Pumps

1. Straight run requirements for end suction pumps shall apply to double suction pumps unless clearly indicated otherwise on project drawings.
2. Pipe fittings, strainers, valves, etc. shall be configured to maintain equal loading on both sides of pump impeller to maintain hydraulically balanced system.
3. Valve shafts shall be oriented parallel to pump shaft.

2.2 START-UP

- A. Prior to placing pump in service, following shall be verified:
 1. Proper pump installation including pump orientation, support base, piping, associated devices and instrumentation
 2. Proper pump/motor alignment
 3. Proper pump rotation
 4. Voltages within manufacturers acceptable range

5. Proper overload protection
 6. Water quality acceptable for use with specified pump seals
- B. Prior to starting pump and placing into service, following shall be accomplished:
1. Pump bearings shall be lubricated if recommended by Manufacturer.
 2. Flow rate of seal recirculating/flush lines shall be adjusted per specification.
 3. Pump shall be primed and air vented.
- C. Pump shall be started and proper operation observed and verified.
- D. Operation without vibration shall be confirmed
1. Vibration of installed and operating pump shall not be detectable by technician, AE or Owner.
 2. If in judgment of AE or Owner, vibration level is deemed unacceptable, vibration analysis shall be performed by qualified technician. Field balance of pump shall be provided as required to bring vibration level within specified limits.
- E. Signed and dated start-up report including any vibration analysis and correction shall be provided to AE.
- F. After initial system cleaning has been completed as addressed in *Section 23 34 16 – Chemical Treatment for Hydronic Systems*, removal of start-up strainer screen shall be verified.

END OF SECTION 232123

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 232213 - STEAM AND CONDENSATE PIPING

PART I - GENERAL

1.1 SUMMARY

- A. This section includes the following:
1. Pipe and Fittings for Building Steam Systems
 2. Valves for Steam and Condensate Systems
 3. Preoperational Cleaning
 4. Pressure Testing

1.2 DEFINITIONS

- A. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
 3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.
- B. Abbreviations:
1. >: Greater than
 2. <: Less than
 3. %: Percent.
 4. ANSI: American National Standards Institute.
 5. API: American Petroleum Institute
 6. ASME: The American Society of Mechanical Engineers.
 7. ASTM: The American Society for Testing of Materials.
 8. AWA: American Welding Association.
 9. CWP: Cold working pressure (PSIG).
 10. E.g.: Exempli gratia "for example."
 11. Etc.: Et cetera "and other similar things"

12. EPDM: Ethylene propylene diene monomer rubber.
13. F: Degrees Fahrenheit.
14. FT or “: Feet
15. HVAC: Heating, Ventilating, and Air-conditioning.
16. I.e.: Id est “in other words.”
17. In or “: Inches.
18. Lb.: Pounds
19. NPT: National pipe thread.
20. PH: Precipitation-hardening.
21. PRV: Pressure regulating valve.
22. PSIG: Pounds-per square-inch gauge pressure.
23. PTFE: Polytetrafluoroethylene.
24. P/T: Pressure / temperature.
25. RPTFE: Reinforced PTFE.
26. SWP: Steam working pressure (PSIG).
27. TFM: Modified PTFE.
28. UIS: The University of Illinois at Springfield.
29. WPB: Welded pipe, butt
30. WPS: Welding procedure specifications

1.3 QUALITY ASSURANCE

- A. Installation, start-up and operation shall be in compliance with Manufacturer’s recommendations and installation, operations, and maintenance manuals.

1.4 SUBMITTALS

- A. Pipe and tubing: Type, material, ASTM number, schedule/wall thickness
- B. Pipe certification, indication of domestic manufacture
- C. Fittings: Type, material, pressure class, ASME number
- D. Flanges: Type, material, pressure class, ASME number
- E. Unions: Type, pressure class, ASME number, material
- F. Flange gaskets: Material, construction, temperature/pressure rating
- G. Valves: Type, pressure class, leakage class, pressure/temperature rating, materials of construction, construction details
- H. Welder Certifications
- I. Leak test report

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Pipe and tubing shall be transported with ends tightly covered. Threaded pipe shall have factory applied end caps maintained in place throughout transportation and storage.

- B. Materials and equipment shall be protected from physical damage and weather during transport.
- C. Pipe, tubing, materials and equipment shall be stored indoors protected from physical damage and exposure to dust and debris.
- D. Large pipe may be stored outdoors on wood blocking with ends tightly covered.
- E. Containers of weld consumables, pastes and fluids shall be stored indoors protected from temperature, physical damage and exposure to fluids, dust and debris. Containers shall remain sealed until use. Opened containers shall be kept sealed when not in use.

1.6 WARRANTY

- A. Products shall be warranted to be free from defects in material and workmanship for period of one year from date placed into useful service or 18-months from date of delivery, whichever occurs first. Defective product shall be repaired or replaced at no cost to Owner.
- B. Joints shall be warranted to be free from leaks and imperfections for same time period. Defective joints shall be repaired or replaced at no cost to Owner.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS FOR BUILDING STEAM AND CONDENSATE SYSTEMS

A. Low Pressure Steam and Condensate

Normal Operation: ≤ 15 -PSIG, ≤ 300 -degrees-F

Worst Case: 25-PSIG (building relief valve setting), 350-degrees-F

1. Pipe and Fittings

a. Size 2" and Smaller

- 1) Pipe: Carbon Steel, ASTM-A53 Grade B - E or S , Schedule Standard
- 2) Fittings: Cast Iron, Class 125, NPT
- 3) Unions: Cast Iron, Class 250, NPT

b. Size 2-1/2" and Larger

- 1) Pipe: Carbon Steel, ASTM-A53 Grade B - E or S , Schedule Standard
- 2) Fittings: Carbon Steel, ASTM-A234 WPB Seamless, Schedule Standard, Long Radius, Welding
- 3) Flanges: Forged Steel, Class 150, ASTM-A105, ASME/ANSI-B16.5, Weld Neck, Raised Face

B. Condensate Gravity Return, Vented

1. Pipe and Fittings

a. Size 2" and Smaller

- 1) Pipe: Carbon Steel, ASTM-A53 Grade B - E or S , Schedule 80, Threaded
- 2) Fittings: Cast Iron, Class 150, NPT
- 3) Unions: Cast Iron, Class 250, NPT

b. Size 2-1/2" and Larger

- 1) Pipe: Carbon Steel, ASTM-A53 Grade B - E or S , Schedule 80

- 2) Fittings: Carbon Steel, ASTM-A234 WPB Seamless, Schedule Standard, Long Radius, Welding
- 3) Flanges: Forged Steel, Class 150, ASTM-A105, ASME/ANSI-B16.5, Weld Neck, Raised Face

C. Pumped Condensate

Normal Operation: <60-PSIG, < 212-degrees-F

Worst Case: Same

1. Pipe and Fittings

a. Size 2" and Smaller

- 1) Pipe: Carbon Steel, ASTM A53 Grade B - E or S , Schedule 80, Threaded
- 2) Fittings: Cast Iron, Class 125, Threaded
- 3) Unions: Cast Iron, Class 250, Threaded

b. Size 2-1/2" and Larger

- 1) Pipe: Carbon Steel, ASTM-A53 Grade B - E or S , Schedule 80
- 2) Fittings: Carbon Steel, ASTM-A234 WPB Seamless, Schedule Standard, Long Radius, Welding
- 3) Flanges: Forged Steel, Class 150, ASTM-A105, ASME/ANSI-B16.5, Weld Neck, Raised Face except where bolted to flat face flange

2.2 JOINING MATERIALS

A. Threaded, flanged and welded pipe connections shall comply with requirements of ASME B31.9 – Building Services Piping and UIS Facilities Standards Section 23 20 00 – Pipe Joining.

B. Threaded Joints

1. Thread Sealant

- a. Paste type, non-hardening, rated for temperature

C. Flanged Joints

2. Gaskets

a. Low pressure steam and condensate

- 1) Compressed non-asbestos
- 2) Synthetic fiber/ Nitrile binder
- 3) Precut ring or sheet material
 - (i) Ring conforms to ASME-B16.21
- 4) Thickness: 1/16"
- 5) Basis of design:
 - (i) Klingersil / C-4401

2. Bolts

- a. Hexagonal: ASME-B18.2.1
- b. Temperatures less than 400-degrees-F

- 1) Carbon steel, ASTM A307 Grade B
- c. Temperatures 400 – 790-degrees-F
 - 1) Alloy steel, ASTM A193 Grade B7
- 3. Nuts
 - a. Hexagonal: ASME B18.2.2
 - b. Temperatures less than 400-degrees-F
 - 1) Carbon steel, ASTM A194 Grade B
 - c. Temperatures 400 – 790-degrees-F
 - 1) Carbon Steel, ASTM-A194 Grade 2H
- D. Welded Joints
 - 1. Materials and Methods: In compliance with Weld Procedure Specifications (WPS)
 - 2. Welding Requirements: In compliance with section below entitled WELDING.

2.3 SHUT-OFF VALVES

Notes:

- 1. Within building systems shut-off valves shall be quarter turn ball or butterfly type. Gate valves within buildings are allowed only for direct replacement of existing gate valves.

B. Low Pressure Steam and Condensate

- 1. Size 2 1/2" and Smaller, Threaded Two-Piece Ball Valve
 - a. 600 CWP, 150 SWP
 - b. Shut-off class VI, bi-directional
 - c. Cast bronze body
 - d. NPT connections
 - e. 316 stainless steel ball
 - f. Vented ball
 - g. 316 stainless steel stem and nut
 - h. Blow-out proof stem design
 - i. Reinforced PTFE (RPTFE) seats
 - j. Adjustable stem packing
 - k. Extended stem to clear insulation
 - l. Latch-lock handle
 - m. Basis of Design
 - 1) Apollo Series / 70-140-64
 - 2) Nibco / T-585-70-66-ST
 - 3) Milwaukee / BA-400S3

2. Size 2-1/2" and Larger, Lug-Style High Performance Butterfly Valve
 - a. ANSI Class 150
 - b. Shut-off class VI, bi-directional
 - c. Stainless steel or carbon steel lug-style body
 - d. 316 stainless steel double-offset disc
 - e. Reinforced TFM seats
 - f. Disc spacers to center disc in seat
 - g. PH-4 stainless steel shaft
 - h. Blow-out proof shaft design
 - i. Stainless steel backed polymer shaft bearings
 - j. Adjustable graphite shaft packing
 - k. Geared rotary hand-wheel operator
 - l. Manufacturers
 - 1) Jamesbury
 - 2) Cameron W-K-M
 - 3) Xomox

C. Pumped Condensate

Normal Operation: <60-PSIG, < 212-degrees-F

1. Size 2 1/2" and Smaller, Threaded Two-Piece Ball Valve
 - a. 2,000-CWP, 150-SWP
 - b. Shut-off class VI, bi-directional
 - c. Carbon steel body
 - d. NPT connections
 - e. 316 stainless steel ball and stem
 - f. Blow-out proof stem design
 - g. Vented ball
 - h. Reinforced PTFE (RPTFE) seats
 - i. Adjustable stem packing
 - j. Extended stem to clear insulation
 - k. Latch-lock handle
 - l. Basis of Design
 - 1) Apollo Series / 73A-140
 - 2) Nibco / TC-580-CS-R-25-LL
 - 3) Milwaukee / 20CSOR-N1-XLH
 - 4) Or a comparable product by:

(i) Jamesbury

2. Size 2-1/2" and Larger, Lug-Style High Performance Butterfly Valve
 - a. ANSI Class 150
 - b. Shut-off class VI, bi-directional
 - c. Stainless steel or carbon steel lug-style body
 - d. 316 stainless steel double-offset disc
 - e. Reinforced TFM seats
 - f. Disc spacers to center disc in seat
 - g. PH-4 stainless steel shaft
 - h. Blow-out proof shaft design
 - i. Stainless steel backed polymer shaft bearings
 - j. Adjustable graphite shaft packing
 - k. Geared rotary hand-wheel operator
 - l. Manufacturers
 - 1) Jamesbury
 - 2) Cameron W-K-M
 - 3) Xomox

2.4 GLOBE VALVES

A. Low Pressure Steam and Condensate

1. Size 2" and Smaller, Cast Bronze Globe Valve
 - a. ANSI Class 150
 - b. Cast bronze body
 - c. Union bonnet
 - d. NPT connections
 - e. Renewable disc
 - f. Basis of design:
 - 1) Nibco / T-235
2. Size 2-1/2" and Larger, Flanged Cast Iron Globe Valve
 - a. ANSI Class 125
 - b. Cast iron body
 - c. Bolted bonnet
 - d. Flanged connections
 - e. Bronze trim
 - f. Renewable disc and seat
 - g. Basis of design:

- 1) Nibco / F-718-B

2.5 SWING CHECK VALVES

A. Low Pressure Steam and Condensate

1. Size 2" and Smaller, Threaded Swing Check
 - a. ANSI Class 150
 - b. Bronze body
 - c. NPT connections
 - d. Renewable disc, regrindable seat
 - e. Basis of design:
 - 1) Nibco / T-433-B
2. Size 2-1/2" and Larger, Flanged Cast Iron Swing Check
 - a. ANSI Class 125
 - b. Cast iron body and cover
 - c. Flanged connections
 - d. Bolted bonnet
 - e. Bronze trim
 - f. Renewable disc and seat
 - g. Basis of design:
 - 1) Nibco / F-918-B

2.6 IN-LINE CHECK VALVES – INDUSTRIAL GRADE

- Typical Application: Condensate Pump Discharge

A. "Severe Duty" Check Valves

1. Size 2" and Smaller
 - a. Repairable non-slam spring-loaded design
 - b. ANSI Class 300
 - c. Steel or stainless steel body
 - d. NPT connections
 - e. 250-degrees-F temperature rating
 - f. Center-guided disc
 - g. Stainless steel trim and disc
 - h. Basis of Design
 - 1) DFT / model SCV
 - 2) Watson McDaniel / WSSCV
2. Size 2-1/2" and Larger
 - a. Repairable non-slam spring-loaded design

- b. ANSI Class 150
- c. Steel or stainless steel body
- d. Wafer or lug style body
- e. 250-degrees-F temperature rating
- f. Center-guided disc
- g. Stainless steel trim and disc
- h. Basis of design
 - 1) DFT / model WLC

PART 3 - EXECUTION

3.1 PIPE AND FITTINGS

- A. Interior of pipe and fittings shall be thoroughly cleaned prior to assembly.
- B. Piping shall be installed plumb and orthogonal relative to floors and walls.
- C. Piping shall be located and configured to avoid interferences and maintain access to valves, devices and equipment requiring service.
- D. Piping shall not be located above electrical panel boards, switchgear, switchboards or motor control centers and shall comply with requirements of *National Electric Code*.
- E. Anchors, expansion joints, swing joints, expansion loops and guides shall be provided as required to provide/control movement and shall be provided as indicated in project drawings.
- F. Piping shall be installed to facilitate insulation.
- G. Horizontal steam piping shall be pitched down 1" per 40' in direction of flow.
- H. Horizontal condensate piping shall be pitched down 1" per 20' in direction of flow.
- I. Eccentric fittings shall be used for changes in pipe size in horizontal lines and shall be oriented with bottom of pipe straight.
- J. Elbows and tees shall be long radius type. Short radius not allowed.
- K. Bull-head tee configuration not allowed.
- L. "Weldolets", "Threadolets" and "Sokolets" may be used for branch connections. Maximum size of branch shall be two pipe sizes smaller than main.
- M. Unless otherwise indicated, branch steam supply piping shall be connected to top or within 45-degrees of top of main.
- N. Condensate drip leg shall be provided at each low point, natural drainage points and end of main in piping system for sediment collection and condensate removal. Inverted bucket steam trap shall be provided at each drip leg.
 - 1. Drip leg shall be full pipe size for main size 4" and smaller, 4" minimum for main size 6" and 1/2 pipe size for main size 8" and larger.
- O. At a minimum, manual isolation valves shall be provided...
 - 1. At branch connections to steam supply mains as indicated on drawings.
 - 2. At supply connections to each unit, device or piece of equipment.
 - 3. At inlet and outlet of each steam control valve or PRV.

4. At inlet and outlet of each steam trap.
- P. At a minimum, unions or flanges shall be provided...
1. At each connection to units, devices and equipment.
 2. At strainers and other specialties.
 3. At equipment or branch side of manual isolation valves.
 4. At inlet and outlet of each trap.
 5. Where required to facilitate removal of piping sections that interfere with tube pulls or equipment removal.
- Q. Horizontal check valve shall be provided at discharge of each steam trap.
- R. Test valve shall be provided at outlet of each steam trap. Test valve shall be line-size, 3/4" minimum.

3.2 PIPE JOINING

- A. Welded and threaded pipe connections shall comply with requirements of *ASME B31.1* and *Section 23 20 00 – Pipe Joining* as applicable.
- B. Threaded Joints
1. Tapered NPT threads shall be properly cut on piping at joints.
 2. Joint sealant shall be applied.
 3. Torque shall be applied to properly seat threads.
- C. Flanged Joints
1. Flanges shall be properly aligned with minimal application of force.
 2. Gasket shall be properly positioned.
 3. Bolts shall be inserted and anti-seize compound applied.
 4. Bolts shall be torqued to specified value.
- D. Welded Joints
1. Reference section below entitled *WELDING*.

3.3 WELDING

- A. Qualifications
1. welders and welding procedure specifications (WPS) shall be qualified as set forth in *ASME Boiler and Pressure Vessel Code, Section IX*
 - a. Welder
 - 1) Prior to performing project welds documentation shall be submitted confirming that each welder has passed required procedure test. Welders shall be qualified as required by ASME-B31.1 or ASME-B31.9 as applicable.
 - 2) Welder qualifications shall be current. If qualification test is more than six months old record of continuity shall be provided indicating welder has performed applicable and approved welding at least every six months since date of qualification test.

B. Weld Inspection and Examination

1. Welds in piping and piping components shall be carefully visually examined in accordance with ASME Standard B31.1 or ASME-B31.9 as applicable.
2. Periodically, as welding progresses, report shall be provided indicating status of project welding quality.

C. Welding Procedures

1. welding shall comply with applicable requirements of referenced ASME and AWA Standards.
2. fittings shall be factory standard fittings. Fabricated fittings not allowed.
3. Backing rings shall not be used with welded joints.
4. Interior of pipe and fittings shall be thoroughly cleaned prior to and after welding/assembly.
5. Welds shall be built up with stringer-bead pass followed by hot pass, followed by cover or filler pass.
6. Valleys at center or edges of welds not allowed. Unsound or unfused metal, cracks, oxidation, blow hoes or non-metallic inclusions not allowed. Any such imperfections shall be corrected in compliance with referenced standards and to satisfaction of AE and Owner.
7. When hot-tapping, slag, drillings or "cookies" shall be prevented from entering piping system to greatest degree possible. Any material that enters piping shall be removed by use of magnet after drilling or cutting is complete.
8. Each weld shall be painted shortly after completion to prevent corrosion.

3.4 VALVES**A. Valve Orientation****1. Ball Valve**

- a. Valve may be installed in manufacturer recommended positions except with stem oriented vertically downward (i.e. with handle at bottom).
- b. Valve shall be installed such that the direction of flow indication on the valve body and/or product literature, if applicable, matches the actual direction of fluid flow through the valve.

2. Butterfly Valve

- a. Valve shall be installed such that shaft is oriented horizontally. In no case shall valve be installed such that shaft is oriented vertically downward (i.e. with the actuator at bottom).
- b. Valve shall be installed such that the direction of flow indication on the valve body and/or product literature, if applicable, matches the actual direction of fluid flow through the valve.

3. Gate and Globe Valves

- a. Valve shall be installed with stem oriented vertically upward. In no case shall valve be installed with stem oriented vertically downward.

4. Check Valve

- a. Swing check valve shall be installed upright in horizontal or vertical upward orientation.
- b. Center-guided and body-guided check valves shall be installed in vertical upward orientation.

B. Valve Insulation

1. Insulated piping applications

- a. Valves in insulated piping systems shall have body, flanges, etc., completely insulated. The practice of leaving heating valves and associated unions/flanges un-insulated is not acceptable.
- b. Insulated valves shall be equipped with extended stems as required to allow operation without disturbing insulation.
- c. Valves shall be provided with lock-out trim where indicated on drawings. Extended stems are not required on valves with lock out trim.

3.5 INSTRUMENTATION

- A. 1/2" minimum thread-o-let with schedule 80 pipe nipple and 1/2" minimum ball valve shall be provided at each connection of pressure instrumentation or instrumentation piping to main (e.g. pressure gauge, pressure gauge piping at pump).

3.6 PREOPERATIONAL CLEANING

A. Traps and Strainers

1. Strainer screens in steam and condensate systems shall be temporarily removed.
2. Steam traps shall be temporarily disconnected from steam and condensate supply piping.

B. Hand Cleaning

1. Slag, burrs, solder, thread sealant, etc. shall be physically removed from interior of installed piping system to degree practical as determined by AE and Owner.

C. Steam Supply Piping

1. Manual and automatic control valves shall be moved to open or closed position as appropriate for flushing.
2. Instruments and components vulnerable to damage/fouling shall be protected from contamination by temporarily removing, "valving off", disconnecting from piping, installing bypass piping, installing temporary "pancakes" at flanged connections.
3. Steam supply piping including drip legs and low points shall be filled with clean water and continuously flushed to sanitary drain until effluent is clean to satisfaction of AE and Owner.
4. Steam supply piping shall be energized with live steam after the required reassembly has been accomplished. Supply piping shall be allowed to "cook" for 12-hours minimum while contaminated condensate is safely captured, cooled and conveyed to drain. Process shall include drip legs and other low points in system. Procedure shall be continued until clean condensate is achieved to satisfaction of AE and Owner.

D. Condensate Piping

1. Steam traps shall be disconnected from condensate piping. Steam traps shall be protected from contamination and shall not be cleaned or flushed internally.
2. Condensate piping including low points shall be filled with clean water and continuously flushed to sanitary drain until effluent is clean to satisfaction of AE and Owner.
3. After flushing is complete, condensate return unit receiver(s) shall be flushed to drain until clean.

E. Reassembly

1. Strainer screens shall be reinstalled.
2. Steam traps shall be reconnected.
 - a.

3.7 INSULATION

- A. After leak testing is complete steam and condensate piping shall be insulated in compliance with Section 23 07 19 – *HVAC Piping Insulation*.

END OF SECTION 232213

This section of the *UIS Facilities Standards* establishes minimum requirements only.

It should not be used as a complete specification.

SECTION 232216 - STEAM AND CONDENSATE SPECIALTIES

PART I - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Strainers
2. Steam Traps
3. Vacuum Breakers

1.2 DEFINITIONS

A. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.

B. Abbreviations:

1. >: Greater than.
2. <: Less than.
3. ≤: Less than or equal to
4. #: Number.
5. %: Percent.
6. ASME: The American Society of Mechanical Engineers.
7. dbA: Decibels (A-weighted).
8. E.g.: Exempti gratia "for example."
9. Etc.: Et cetera "and other similar things"
10. F: Degrees Fahrenheit.
11. F&S: Facilities and Services
12. FT or ": Feet
13. F&T: Float and thermostatic
14. Hg: Mercury.

15. HVAC: Heating, Ventilating, and Air-conditioning.
16. I.e.: Id est "in other words."
17. In or ": Inches.
18. NPT: National pipe thread.
19. PRV: Pressure regulating valve.
20. PSID: Differential pressure (PSIG)
21. PSIG: Pounds-per square-inch gauge pressure.
22. SCFC: Standard cubic feet per minute.
23. UIS: The University of Illinois at Springfield.

1.3 QUALITY ASSURANCE

- A. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and installation, operations, and maintenance manuals.

1.4 SUBMITTALS

- A. Strainers: Type, materials of construction, temperature/pressure rating, strainer screen mesh size.
- B. Steam traps: Type, design, materials of construction, temperature/pressure rating, parameters, size/capacity. Trap schedule shall be submitted.
- C. Vacuum breakers: Type, materials of construction, temperature/pressure rating, capacity.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials and equipment shall be protected from physical damage and weather during transport.
- B. Materials and equipment shall be stored indoors protected from physical damage and exposure to dust and debris.
- C. Materials and equipment shall be protected from physical damage and exposure to dust and debris during construction.

1.6 WARRANTY

- A. Products shall be warranted by manufacturer to be free from defects in material and workmanship for period of one year from date of startup or 18-months from date of delivery, whichever occurs first. Manufacturer shall repair or replace failed item at no cost to UIS.
- B. Joints shall be warranted to be free from leaks and imperfections for same time period. Defective joints shall be repaired or replaced at no cost to UIS.

PART 2 – PRODUCTS

2.1 Y-PATTERN PIPELINE STRAINERS

- A. Low Pressure Steam and Condensate \leq 15-PSIG (25-PSIG worst case)
 1. Size 2" and Smaller, Threaded Cast Iron
 - a. Pressure class 125
 - b. Cast iron body
 - c. NPT connections
 - d. Threaded blow-off connection
 - e. 20 mesh stainless steel screen

2. Size 2-1/2" and Larger, Flanged Cast Iron
 - a. Pressure class 125
 - b. Cast iron body
 - c. Flanged connections
 - d. Threaded blow-off connection
 - e. Size 2-1/2" through 4": 1/16" perforated stainless steel screen
 - f. Size 6" and larger: 1/8" perforated stainless steel screen
3. Size 2-1/2" and Larger, Flanged Cast Steel
 - a. Pressure class 150
 - b. Cast steel body
 - c. Flanged connections
 - d. Threaded blow-off connection
 - e. Size 2-1/2" through 4": 1/16" perforated stainless steel screen
 - f. Size 6" and larger: 1/8" perforated stainless steel screen

2.2 STEAM TRAPS

A. Rating

1. Trap body and internals shall be rated for minimum of 1.5-times system design operating pressure or relief valve pressure setting, whichever is greater. Trap shall be rated for simultaneous temperature listed.
 - a. Low pressure system ≤ 300 -degrees-F
 - 1) $1.5 \times 15 = 22.5$ -PSIG
 - 2) Relief valve setting = 25-PSIG

B. Inverted Bucket

1. Body: Cast iron
2. Cover: removable, bolted
3. Internals, including valve and seat: Replaceable, stainless steel
4. Connections: NPT
5. Manufacturers:
 - a. Armstrong
 - b. Sarco
 - c. Mepco

C. Float and Thermostatic

1. Body: Cast iron
2. Cover plate: Removable, bolted
3. Internals, including valve and seat: Replaceable, stainless steel
4. Connections: NPT
5. Manufacturers

- a. Armstrong
 - b. Sarco
 - c. Mepco
- D. Thermostatic (Radiator)
1. Body: Bronze or brass
 2. Cover: Removable, threaded
 3. Valve and seat: replaceable, stainless steel
 4. Diaphragm: replaceable phosphor bronze or stainless steel
 5. Connections: NPT with integral union
 6. Manufacturers
 - a. Watts (Illinois Engineering)
 - b. Mepco
 - c. Barnes and Jones
 7. Options for coordination with existing conditions:
 - d. Same as other existing traps within building if predominant
 - e. Direct replacement of existing traps to avoid unnecessary pipe modifications
- E. Thermodynamic
1. Body: stainless steel
 2. Cover: removable, threaded
 3. Disc and seat: replaceable, stainless steel
 4. Connections: NPT
 5. Manufacturers
 - a. Armstrong
 - b. Sarco
 - c. Mepco
- F. Sizing
1. Traps shall be sized with warm-up safety factor as recommended by manufacturer for application.

2.3 VACUUM BREAKERS

- A. Stainless steel construction
- B. 1/2" or 3/4" NPT connection
- C. Rated 300-PSIG, 400-degrees-F
- D. 10-SCFM (minimum) at 0.5" Hg (maximum)
- E. Basis of Design
 1. Armstrong / VB21
 - a. 1/2" NPT connection, 10-SCFM airflow rate at 0.35" Hg cracking pressure

PART 3 - EXECUTION

3.1 STRAINERS

A. Y-Pattern Pipeline Strainers

1. Strainer blowdown connection shall be fitted with drain valve nipple and cap. Drain valve shall be full port ball valve per specifications for service. Reference section 23 22 13 *Steam and Condensate Piping* for valve specifications.
2. Strainer shall be installed in horizontal piping or in vertical piping with downward flow.
3. Strainer located in horizontal line shall be installed with basket in horizontal plane to prevent condensate build-up in basket.
4. Strainer shall be provided in steam system upstream of each control valve and at other locations indicated on drawings.
5. Strainer shall be provided in condensate system upstream of each trap and at other locations indicated on drawings.
6. Pipe union shall be provided downstream of each strainer with threaded connections to facilitate removal.

3.2 STEAM TRAPS

- A. Steam trap shall be provided at outlet of each steam utilizing device or piece of equipment to provide full condensate drainage. Trap shall be located for ease of access to facilitate service and removal/replacement.
- B. Steam trap shall be provided at each low point and at end-of-main in steam system to prevent collection of condensate in piping and maintain a dry steam system.
- C. Traps serving equipment with modulating control valves shall be F&T type to provide continuous condensate removal and venting of large volumes of air. F&T traps shall be piped for full gravity drainage without vertical lift.
- D. Traps for drip applications shall be inverted bucket type for robustness and fail-open function. Drip traps may be piped with vertical lift within pressure differential limitations.
- E. Traps for on-off applications may be inverted bucket or thermodynamic type. On-off traps may be piped with vertical lift within pressure differential limitations.
- F. Drip leg with scale pocket shall be provided for each trap. Drip leg shall be extended and trap positioned such that trap inlet is no less than 14" below bottom of steam pipe or device outlet. Where potential for superheated steam exists, trap inlet shall be no less than 28" below steam pipe.
- G. Trap shall be positioned such that distance from drip leg to trap inlet is no greater than 18" to prevent trap locking.
- H. Strainer shall be provided at each trap inlet.
- I. Test valve and swing check valve shall be provided at each trap outlet. Pipe unions shall be provided at trap inlet and outlet to facilitate removal.
- J. Exceptions for thermostatic traps serving radiators, fin tube and similar applications where space constraints dictate:
 1. Drip leg may be reduced.
 2. Strainer may be deleted.
 3. Test valve and/or check valve may be deleted.

K. Trap Application Table:

Application	Trap Type	Notes
HW converter	F&T	
Air coil	F&T	
Domestic water heater	F&T	
Low point drip, end-of-main drip	Inverted bucket	
Radiator, convector, fin tube	Thermostatic	Reduced drip leg allowed
HP process equipment	Thermodynamic	e.g. Lab sterilizer, cage washer

L. Drip Leg Sizing Table:

Main Size	Drip Leg Size, Minimum
4" and smaller	Full main size
6"	4"
8" and larger	1/2 main size

3.3 VACUUM BREAKERS

- A. Vacuum breakers shall be installed in vertical upright position.
- B. Steam coil applications
 - 1. Vacuum breaker shall be provided at coil outlet. Elevation shall be at or above coil outlet. Vacuum breaker shall not be located at steam trap elevation.
- C. Heat exchanger applications
 - 1. Vacuum breaker shall be provided at shell connection provided by manufacturer for such purpose. If no such connection exists vacuum breakers shall be provided as indicated above for steam coil.
- D. Additionally, vacuum breakers shall be provided at other locations indicated on drawings.

3.4 INSULATION

- A. Steam and condensate specialties shall be insulated in compliance with *Section 23 07 16 – HVAC Equipment Insulation*.

END OF SECTION 232216

This section of the *UIS Facilities Standards* establishes minimum requirements only.

It should not be used as a complete specification.

SECTION 232223 - STEAM CONDENSATE PUMPS

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Steam Condensate Return Units, Gravity Return Type
 - 1. Receiver
 - 2. Pumps
 - 3. Control Panel
 - 4. Accessories

1.2 QUALITY ASSURANCE

- A. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

1.3 SUBMITTALS

- A. Full unit description including accessories
- B. Dimensional data, capacities, materials of construction, shipping weight
- C. Detailed pump, motor and control panel componentry
- D. Pump performance curve with design operating point indicated
- E. Motor characteristics as indicated in schedule
 - 1. Phase, voltage, full load amps, efficiency, frequency (Hz.)
- F. Wiring diagram
- G. Piping diagram
- H. Operation and maintenance manual

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Control panel shall be shipped separately from pump unit.
- B. Control panel and pump unit shall be protected from physical damage and weather during transport.
- C. Control panel and pump unit shall be stored indoors protected from physical damage and exposure to dust and debris.
- D. Control panel and pump unit shall be protected from physical damage and exposure to dust and debris during construction.

1.5 WARRANTY

- A. Pump unit and control panel shall be warranted to be free from defects in material and workmanship and to perform as specified for period of one year from date of startup or 18 months from date of delivery, whichever occurs first. Defective product shall be repaired or replaced at no cost to Owner.

PART 2 - PRODUCTS

2.1 STEAM CONDENSATE RETURN UNIT

Design/Performance Requirements:

A. Separable Unit

1. Control panel shall be separable from unit for remote mounting.
2. Unit, including control panel, shall be factory tested as complete assembly.

B. Receiver Tank

1. Horizontal configuration
2. Sized as indicated in *PART 3 - EXECUTION*
3. Cast iron construction
4. Lifting eye bolts
5. Connections for pump, vent, drain, overflow, gauge glass and thermometer
 - a. NPT or flanged

C. Pumps

1. Duplex, vertical centrifugal
2. Tank mounted
3. Direct coupled
4. Rated 210F condensate @ 2' NPSH
 - a. Continuous operation at design conditions
 - 1) No cavitation
 - 2) No damage to seals
5. Design operating parameters
 - a. Discharge pressure and NPSH as scheduled on drawings or otherwise indicated in project documents.
6. Renewable bronze casing wear ring
7. Enclosed bronze impellor with suction inducer
8. Stainless steel shaft
9. Sealed ball bearings, grease lubricated
10. Mechanical seals
 - a. Component seal, rotary design
 - b. Carbon/silicon carbide seal faces
 - c. Viton O-rings
 - d. Rated 250F continuous operation
 - e. Discharge flush lines
 - f. RPM as scheduled on drawings or otherwise indicated in project documents

D. Pump Motors

1. Electrical characteristics as scheduled or otherwise indicated in project documents
2. ¾ HP and smaller – single phase
3. 1 HP and larger – three phase
4. Compliant with requirements of *Section 26 60 00 – Common Motor Requirements*

E. Control Panel

1. NEMA 1 enclosure with hinged cover
2. UL listed
3. NEMA rated components
4. Factory assembled and wired
5. Configured for two power sources
 - a. Dedicated power circuit per pump
6. Combination fused disconnects
 - a. Fuses sized 125-130% motor FLA
7. Magnetic starters with overload relays
8. Hand-off-auto switch, each motor
9. Independent control circuits
10. Fusible control circuit transformer
11. Pump alternator
12. Lead-off-lag selector switch
 - a. Each motor functional when power off to other
13. Externally adjustable double pole float switches
14. Pump running pilot light for each motor
15. High level alarm dry contacts
16. Stainless steel floats and float rods

F. Accessories

1. Inlet basket strainer
2. Pump inlet isolation valves
 - a. No impact on pump performance
 - b. Positive shut-off when pump removed
3. Gauge glass
4. Dial thermometer
5. Discharge pressure gauge, each pump

G. Manufacturers

1. Mepco
2. ITT Domestic

3. Shipco
4. Spirax/Sarco

PART 3 - EXECUTION

3.1 STEAM CONDENSATE RETURN UNIT

- A. Sizing
 1. Pump and receiver capacities shall be as scheduled minimum.
- B. Equipment Curb
 1. Pump receiver shall be firmly affixed to concrete equipment curb.
 2. Curb shall be steel reinforced, dowelled into floor.
- C. Control Panel Installation
 1. Panel shall be permanently mounted on ridged structure at location indicated on drawings.
 2. Panel shall be readily accessible at convenient elevation.
 3. Panel and pump unit shall be field wired in accordance with Manufacturer's instructions.
 4. Panel installation and wiring shall be in compliance with NEC.
- D. Wiring
 1. Interconnecting wiring between the pump controls and control panel shall be enclosed in liquid tight flexible conduit.
- E. Adjustment
 1. Floats shall be adjusted per manufacturer's instructions.
 2. Condensate bypass piping shall be provided to facilitate float adjustment .
- F. Valves
 1. Severe duty check valve shall be provided in each pump discharge line. See specifications.
- G. Vent
 1. "Oversized" vent piping shall be provided to minimize receiver pressure.
 2. Vent pipe size shall be "engineered" to ensure pressure in receiver tank does not exceed atmospheric pressure.
 3. Vent pipe size calculation shall be based upon substantial flash steam and trap blow-through into receiver.
 4. Vent pipe shall be extended through roof and terminated open to atmosphere.
 5. Vent pipe shall be routed and terminated as indicated on drawings.

END OF SECTION 232223

This section of the *UIS Facilities Standards* establishes minimum requirements only.

It should not be used as a complete specification.

SECTION 232300 - REFRIGERANT PIPING

PART I - GENERAL

1.1

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Fittings and flanged unions shall be cast brass or wrought copper refrigeration type fittings. Cast fittings shall be internally tinned before use.
- B. Vibration eliminators shall be located in the piping. Sizes above 3" shall be the stainless steel type designed to restrict freedom of movement in three dimensions.
- C. With multiple evaporator and/or compressor units, piping connections shall be arranged to prevent gravity flow of oil or liquid refrigerant into the compressor.
- D. Hot gas and suction velocities shall be not less than 500 fpm in horizontal lines and 1000 fpm in vertical lines. Where capacity control is used, double pipe risers and oil traps should be used to avoid dropping below 1000 fpm in vertical lines. In sizing suction lines, it is generally desirable to limit the pressure drop to one (1) psi.

2.2 REFRIGERANT PIPING

- A. All refrigerant piping shall be Type "L" ACR hard copper with long radius fittings. The composition of the solder depends on the location in the system:
 - 1. For pipe runs and joints (copper to copper), Staz-Silv or Silfos, a solder composition with 15% silver (BCUP-S) shall be used.
 - 2. Where dissimilar metals are joined, such as copper to brass or copper to steel, Staz-Silv or "easy-flow", a solder composition with 45% silver (BAG-1) shall be used.
 - 3. Where auxiliary components, such as expansion valves are involved, Staz-brite (soft solder) with tin and 4% silver shall be used so parts can be readily changed as needed.
- B. When soldering, a nitrogen bleed shall be used to keep pipe and fitting from being oxidized.

PART 3 - EXECUTION

3.1 DEHYDRATION AND AIR REMOVAL

- A. Refrigeration systems shall be thoroughly dehydrated and evacuated before charging with refrigerant. Systems shall be evacuated with a vacuum pump to an absolute pressure of not less than 500 microns mercury. Dryer cartridges shall be replaced until all water has been removed. These processes shall be described in the specifications in the greatest possible detail so no question can exist regarding the efficiency of air and water removal required.

END OF SECTION 232300

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 232500 - WATER TREATMENT FOR HYDRONIC SYSTEMS

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Closed Loop Hot Water and Chilled Water Systems – Water Treatment, Freeze Protection
- B. See *Section 23 22 13 Steam and Condensate Piping* for cleaning of steam systems.

1.2 QUALITY ASSURANCE

- A. Products and execution shall be in compliance with all applicable codes and standards.
- B. All aspects of chemical management shall be in compliance with manufacturer's and supplier's recommendations and instructions.

1.3 SUBMITTALS

- A. Following shall be provided for chemicals including glycol.
 - 1. Product Information
 - a. Manufacturer, Product ID, Ingredients, Concentrations
 - 2. Safety Data Sheet (SDS), formerly Material Safety Data Sheet (MSDS)
 - 3. Manufacturer's Instructions and Recommendations
 - a. Storage, handling, disposal
 - b. Concentration and dosage
 - c. Mixing and introduction into system
- B. Following shall be provided for bag filters. See *Section 23 25 10 – Fluid Filtration* for requirements.
 - 1. Manufacturer's product information
 - 2. Manufacturer's IOM
- C. Chemical Discharge Request Form shall be provided.
 - 1. Form shall be submitted to Owner prior to draining.
- D. Startup report shall be provided for each system.
 - 1. Total quantity water in system
 - 2. Quantity chemical treatment or glycol Added
- E. Field service log shall be provided and maintained.
 - 1. Up-to-date on-site log with records of:
 - a. Test results
 - b. Chemical adjustments
 - c. Filter bag changes
- F. Field service test reports shall be provided.
 - 1. Test results shall be recorded in service log.
- G. Full Lab Analysis Reports shall be provided. See paragraph *3.7 Sample Lab Report* for examples.
 - 1. For water and glycol systems

2. At system startup and at end of warranty period

1.4 QUALITY ASSURANCE

- A. Chemicals shall be provided by reputable, Owner-approved chemical treatment company.
- B. Oversight of initial cleaning and chemical treatment shall be provided by same.
- C. Service visits, testing and adjustments shall be performed by same.
- D. Full lab analysis for water system shall be performed by Owner-approved laboratory.
- E. Full lab analysis for glycol system shall be performed by glycol vendor or Owner-approved laboratory.

1.5 WARRANTY

- A. Contractor shall warrant full compliance with the following for period of one year from system startup:
 1. Hydronic system cleanliness and water chemistry shall be maintained within specified limits.
 2. No hindrance to system functionality or damage to system components shall occur as a direct or indirect result of chemical treatment and/or filtration deficiencies.

PART 2 - PRODUCTS

2.1 CLEANING AND TREATMENT CHEMICALS - CLOSED LOOP SYSTEMS

- A. Cleaning Agent
 1. Cleaning Solution
 - a. Cleaning solution shall be formulated to remove solder flux, cutting oils, loose mill scale, construction debris and organics.
 - b. Chemical cleaner shall typically be an aqueous solution of trisodium phosphate and caustic soda.
 - c. Cleaning solution shall not be harmful to system materials of construction.
 - d. PH of system fluid shall be maintained above 9.5 during cleaning process to assist with formation of passivating film.
- B. Chemical Treatment – Hot Water and Chilled Water Systems
 1. Corrosion Inhibitor
 - a. Corrosion inhibitor shall be a multi-functional blend including:
 - 1) Sodium Nitrite and/or Molybdate (inhibitor)
 - 2) Tolytriazole (copper protection)
 - 3) Borax and/or Potassium Phosphate (pH Buffer)
 - b. Concentration in system fluid shall be maintained as follows:
 - 1) Nitrite: 500-800 ppm
 - 2) Molybdate: 100 ppm minimum (as applicable)
 - 3) Tolytriazole: 10 ppm minimum
 - 4) Borax: 100 ppm minimum
 - 5) Phosphate: 100-200 ppm (as applicable)
 - c. pH of system fluid shall be maintained at 9.5-10.5

- d. Basis of Design:
 - 1) Nalco / 8338
 - 2) Illinois State Mix / #2900-141-0061
- C. Ethylene Glycol
 - 1. Composition
 - a. Ethylene glycol: $\geq 92.4\%$ by weight
 - b. Inhibitors and water: 7.6%
 - c. Specific gravity, 60/60F: 1.130-1.144
 - d. Dye: Fluorescent orange, green not allowed
 - e. Reserve alkalinity (ASTM D1121): ≥ 25 ml
 - f. pH 1.1 dilution: 8.5-9.0
 - g. Antifoam (as required to prevent foaming at air vents)
 - 2. Basis of Design:
 - a. Dowtherm / 4000
 - b. Interstate / Intercool OP-100 RA-25
 - 3. Disallowed
 - a. Rocktherm
 - b. Ethylene glycol manufactured by Butler Chemical Company
 - c. Automotive antifreeze
 - d. Any formulation containing silicates
 - 4. Exception: Systems with aluminum components shall receive an alternate formulation. Silicates will typically be required.

2.2 BAG FILTERS

- A. See Section 23 25 10 – *Fluid Filtration* for requirements.

PART 3 - EXECUTION

3.1 PREOPERATIONAL CLEANING – CLOSED LOOP SYSTEMS

- A. System Filling
 - 1. Entire system shall be filled with clean water and air vented.
 - 2. Meter shall be used during filling to determine system volume.
 - 3. Measured system volume shall be stenciled in professional manner on exterior of insulated heat exchangers(s).
- B. Leak Testing
 - 1. Hydrostatic test of system shall be performed as specified in Section 23 21 13 *Hydronic Piping*.
- C. System Cleaning
 - 1. Devices vulnerable to damage or fouling by cleaning fluid shall be bypassed or valved off without hindering system circulation.

2. All manual isolation valves, balance valves and automatic control devices shall be placed in full open position. Procedure shall be coordinated with Temperature Control Contractor.
3. Cleaning solution shall be slowly added to system. Quantity shall be based upon metered system volume. Cleaning solution shall typically be added to system via bypass bag filter vessel (filter vessel doubles as chemical pot filter).
4. Cleaning solution shall be circulated throughout entire system for 48 hours minimum.
5. If possible, heat shall be added to system throughout circulation period. Heated water temperature shall be approximately 160F. If heat is added circulating time may be reduced to 24 hr.
6. PH of system fluid shall be maintained between 9.5 and 10.5 throughout cleaning process.
7. Fluid velocity shall be maintained at 5 ft/sec minimum through all branches and 3 ft/sec minimum within mains. Multiple pumps shall be operated and/or system shall be sectionalized as required to maintain required velocity.
8. Bypass bag filter shall be active throughout circulation period. Bags shall be changed as loaded. Startup and Maintenance procedure for filter shall be implemented as presented in Section 23 25 10 *Fluid Filtration*.
9. Once required cleaning period has been completed and while system is still being circulated, fluid shall be drained from system while clean water is added at same rate. Referred to as "flush-and-fill". Effluent shall be directed to sanitary drain.
10. Flush-and-fill process shall be continued until clean discharge fluid is achieved at all low point drains.
11. Samples of clean fluid shall be drawn by Owner for analysis. Samples shall be drawn from Owner selected sites.
12. Flushing shall be continued and fluid samples drawn until Owner approval achieved.
13. All strainers shall be removed, cleaned and reinstalled. Pump start-up screens shall be removed and temporarily attached to pump/piping for later inspection.
14. Bypass piping shall be removed and components and instruments returned to operational configuration.
15. Dirty bypass filter shall be replaced with clean filter bag.

3.2 CHEMICAL TREATMENT

- A. Chemical treatment shall be slowly added to system. Quantity shall be based upon metered system volume.
- B. Chemical treatment shall typically be added to system via bypass bag filter vessel (doubles as pot feeder).
- C. System fluid shall be circulated until thoroughly mixed.
- D. Concentration of chemical components shall satisfy requirements of *2.1B Chemical Treatment* above.
- E. Post-treatment sample of system fluid shall be provided to Owner for analysis. Sample shall be drawn in presence of Owner.
- F. Adjustments shall be made by until Owner approval is achieved.

3.3 GLYCOL

- A. Ethylene glycol solution shall be added to system with portable glycol fill unit. Quantity shall be based upon metered system volume.

- B. Glycol shall be premixed with water prior to introduction into system. Requirement may be relaxed with Owner approval.
- C. System fluid shall be circulated until thoroughly mixed.
- D. Concentration of ethylene glycol shall be 30% ± 2% by weight unless indicated otherwise in documents.
- E. Post-treatment sample of system fluid shall be provided to Owner for analysis. Sample shall be drawn in presence of Owner.
- F. Adjustments shall be made until Owner approval is achieved.

3.4 CHILLED WATER FROM CENTRAL SYSTEM – ADDITIONAL REQUIREMENTS

- A. Building chilled water system shall be isolated from central system by closing service entrance valves.
- B. Temporary pumping apparatus shall be provided. Hoses/piping shall be provided and attached to pipe connections.
- C. Chemical cleaning and flushing procedures specified above for closed loop systems shall be followed.
 - 1. Given that it may not be possible to achieve specified fluid velocity in mains, velocity shall be maintained as high as practical.
 - 2. Note: When building isolation valves are closed there is no provision for thermal expansion of system fluid.

3.5 EXISTING SYSTEMS - ADDITIONAL REQUIREMENTS

- A. Existing system shall be drained prior to making new connections.
- B. System fluid shall be properly disposed of unless approved by Owner for reuse.
 - 1. Method and rate of disposal of contaminated fluids, ethylene glycol in particular, shall conform to Owner's requirements.
- C. Existing system shall be filled with clean water, flushed and drained prior to making new connections.
- D. Entire system (new and existing) shall be filled, tested, cleaned, flushed and chemically treated/filled with glycol solution as indicated above for new systems. Scope of work for existing system may be reduced as appropriate and as approved by AE and Owner.

3.6 EXPANSION TANK ADJUSTMENT

- A. Expansion tank charge shall be adjusted. Following procedure shall be followed.
 - 1. Ensure system fluid is at room temperature.
 - 2. Ensure all air is vented from system.
 - 3. Close valve between expansion tank and system.
 - 4. Open bent/drain valve at expansion tank.
 - 5. Adjust air pressure to value indicated in documents.
 - a. Preferred method: Provide pressure gauge at highest point in system. Adjust tank air pressure to yield 5-10 PSIG at highest point.
 - b. Alternate method if preferred method is not achievable: If actual height of system is known adjust pressure to height of system above tank plus 10-20 ft. (convert to PSIG). Height of system must be known with accuracy to apply this method.

6. Close drain/vent at tank.
7. Open valve between expansion tank and system.

3.7 FIELD SERVICE

A. Frequency

1. Chemical treatment shall be tested and adjusted.
 - a. Quarterly throughout warranty period
 - b. Additionally as required to maintain specified system chemistry and proper system operation
2. Bypass bag filter shall be changed as required throughout warranty period. See Section 23 25 10 – *Fluid Filtration* for Requirements.

B. Log Sheet

1. Shall be provided and maintained by chemical treatment company
 - a. Shall be enclosed in protective cover attached to bypass filter
2. Shall include record of all on-site tests, adjustments and filter changes
 - a. Shall be dated and initialed each visit

3.8 TESTS

- A. System fluids tests shall be conducted at each field service visit. Tests shall include the following at a minimum:
 1. Water System - pH, conductivity, primary corrosion inhibitor levels (nitrite and/or molybdate), metal levels (iron and copper), particulate
 2. Glycol System - % ethylene glycol by weight, reserve alkalinity, metal levels (iron and copper), particulate

3.9 LAB ANALYSIS

- A. Full lab analysis shall be performed at system startup and at end of warranty period.
 1. Water system analysis shall be performed by reputable, Owner-approved laboratory.
 2. Glycol system analysis shall be performed by glycol vendor or Owner-approved laboratory.
 3. Scope of analysis for each system shall be as identified in Section 3.11 *Sample Lab Report* at minimum and shall include all line items.
 - a. Additionally:
 - (a) Test for ammonia level shall be performed.
 - b. ATP test for biological growth shall be performed if presence of ammonia is detected.

3.10 WARRANTY PERIOD

- A. Field Service and Tests shall be provided throughout warranty period as required by Paragraph 3.7 *FIELD SERVICE* and 3.8 *TESTS* above.

3.11 SAMPLE LAB REPORTS

- A. Provided on pages below are samples of lab analysis reports
 1. Water System – Full Lab Analysis
 2. Glycol System – Full Lab Analysis

WATER SAMPLE ANALYSIS

<i>Analyst:</i>	<i>Facility:</i>
<i>Sample Type:</i>	<i>Attention:</i>
<i>Location:</i>	<i>Additional Information:</i>
<i>Date Collected:</i>	

<i>Parameter</i>	<i>Value</i>	<i>Units</i>
P Alkalinity (as CaCO ₃)	135	mg/L
M Alkalinity (as CaCO ₃)	260	mg/L
Hardness (as CaCO ₃)	56 Site	mg/L
Sulfate (SO ₄)	100	mg/L
Chloride (Cl)	430	mg/L
Silica (SiO ₂)	1.6	mg/L
Iron (Fe)	0.00	mg/L
Copper (Cu)	0.34	mg/L
Zinc (Zn)	0.00	mg/L
Aluminum (Al)	0.30	mg/L
Total Suspended Solids	19	mg/L
Total Phosphate (PO ₄)	3.68	mg/L
Sodium (Na)	354.7	mg/L
Molybdenum (Mo)	0.04	mg/L
Total Dissolved Solids	1064	mg/L
Conductivity	1788	uS/cm
pH	9.89 Site	pH units
pH Temperature	26.2 Site	deg. C
Nitrite (NO ₂)	300	mg/L
Borate (8204)	33	mg/L
Triazole	0.6	ppm
Ammonia (NH ₄)	8.0	mg/L

Comments

Hardness: Somewhat High at 56 mg/L.

Iron and Zinc: None, good.

Copper: Slightly High at 0.34 mg/L.

Aluminum: Somewhat High at 0.30 mg/L.

Molybdenum: Low but present at 0.04 mg/L.

Total Suspended Solids: Slightly High at 19 mg/L.

pH: Satisfactory at 9.89. Target range is > 9.5.

Nitrite: Low at 300 mg/L. Target range is 500-800 mg/L.

Borate: Low at 33 mg/L, below the target range of 300-600 mg/L.

Tolyltriazole: Extremely Low at 0.6 mg/L, recommended range is 2-5 mg/L.

Ammonia: Somewhat high at 8.0 mg/L. Recommended levels are under 20 mg/L.

Glycol Fluid Analysis

	<i>Test</i>	<i>Results</i>	<i>Recommended Levels</i>
<i>General Tests</i>	Glycol (Vol%): Propylene	24	25% - 65%
	Freeze Point (deg F):	+16	10 to -68
	pH:	8.90	8.0 - 9.5
	Color, Clarity, Oil:	Yellow, Clear, No Oil	
<i>Degradation Products</i>	Iron (Fe), ppm:	0	< 5
	Copper (Cu), ppm:	0	< 5
	Aluminum (Al), p	0	< 5
	Zinc (Zn), ppm:	0	< 5
<i>Scale Promoters</i>	Magnesium (Mg), ppm:	0	< 1
	Calcium (Ca), ppm:	0	< 1
<i>Contaminants</i>	Silica (SiO2), ppm:	16	< 25
	Nitrate (NO3), ppm:	22	< 25
	Molybdenum (Mo), ppm	0	< 25
	Lead (Pb), ppm	0	< 5
	Arsenic (As), ppm	0	< 5
<i>Corrosives</i>	Chloride (Cl), ppm:	45	< 25
	Sulfate (SO4), ppm:	23	< 25
	Acidity (Organic):	280	< 1000
<i>Inhibitors</i>	Phosphate (PO4), ppm:	3205	2250 - 3750
	Boron (B), ppm:	61	> 150
	Nitrite (NO2), ppm:	11	> 250
	Tolytriazole (TZ), ppm:	124	> 150
	NACAP, (MBT), ppm		> 150

Comments and Recommendations:

END OF SECTION **232500**

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 232510 - FLUID FILTRATION

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Bypass Bag Filter
 - 1. Permanent Unit
 - 2. Temporary Unit

1.2 QUALITY ASSURANCE

- A. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

1.3 SUBMITTALS

- A. Unit description
- B. Unit data
- C. Performance data
- D. Piping diagram
- E. Operation and maintenance manual

1.4 WARRANTY

- A. Assembled unit shall be warranted by manufacturer to be free from defects in material and workmanship for period of one year from date of startup or 18 months from date of delivery whichever occurs first. Manufacturer shall repair or replace unit at no cost to Owner.

PART 2 - PRODUCTS

2.1 FLUID FILTRATION EQUIPMENT

- A. Hydronic Heating/Cooling Systems - Bag Type Bypass Filter
 - 1. Housing and cover
 - a. Stainless steel - Units with connection size 2" and smaller
 - b. Epoxy coated steel - Units with connection size 2 1/2" and large
 - 2. Davit for cover removal if cover exceeds 50 lb.
 - 3. Eye bolt cover retainers
 - 4. Support legs
 - a. Material of construction to match housing
 - 5. Pipe connections, inlet and outlet
 - a. NPT - Pipe size 2" and smaller
 - b. Flanged - Pipe size 2 1/2" and larger
 - 6. Air vent and drain connections
 - 7. Pressure gauge ports (for differential pressure measurement)
 - 8. Perforated stainless steel basket(s)
 - 9. Filter bag(s)

- a. Fully welded construction
 - b. Locking seal ring to provide 100% bypass-free filtration
 - c. Bag Insertion tool to ensure correct alignment
 - d. 50-micron polyester felt bag(s) for initial system "rough cleaning"
 - e. 25-micron oil-absorbent polypropylene microfiber bag(s) for oil removal
 - f. 10-micron polyester felt bag(s) for final filtering and on-going system maintenance
10. Housing/cover assembly rated for 150 PSIG
 11. All components including filter bags rated for 250 degrees F
 12. All components including filter bags approved for use with ethylene glycol/water solutions up to 50% concentration
 13. Size
 - a. Provide Size 01 unit (minimum) for systems with total design flow rate of 50 GPM or less.
 - b. Provide Size 02 unit (minimum) for systems with total design flow rate greater than 50 GPM.
 - c. Provide unit with multiple bags for systems with design flow rate of 800 GPM or greater.
 - d. At a minimum, size for flow rate of 10% system design flow rate through 10 micron filter with 2 PSIG maximum clean-filter pressure drop, 1 cps system fluid viscosity.
 14. Approved Manufacturers:
 - a. Basis of Design: FSI (Filter Specialists Inc.)
 - b. Other approved:
 - 1) Eaton Filtration
 - 2) Rosedale Products
 - 3) Siemens Water Technologies
 - c. Not approved:
 - 1) LeSac Corporation

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hydronic Heating/Cooling Systems - Bag Type Bypass Filter

1. Install filter unit in bypass piping between pump discharge main and pump suction main. Piping shall be configured to allow blow-down discharge from air-dirt separator to be directed into filter inlet piping. Refer to applicable drawing detail.
2. Provide rigid structural support using factory fabricated legs.
3. Provide check valve and properly sized adjustable flow-limiting valve (see section 23 21 13 *Hydronic Piping* for specification).
4. Provide shut-off valves for isolation of bypass piping from main system piping. Locate at tie-in points to mains.
5. Provide shut-off valves in bypass piping at filter inlet and outlet openings to minimize fluid loss when cover is removed. Locate each valve at elevation of associated inlet or outlet opening.

6. Provide pressure gauge piped across gauge ports. Include shut-off valves.
7. If differential pressure monitoring via BAS is required, provide differential pressure transmitter installed in parallel with pressure gauge.
8. Provide air vent valve with hose adapter and cap.
9. Provide drain valve with hose adapter and cap.
10. Provide insulation of filter and associated piping, valves, etc. as appropriate for fluid media temperature.

3.2 START-UP AND MAINTENANCE

A. Hydronic Heating/Cooling Systems - Bag Type Bypass Filter

1. At initial startup, balance fluid flow rate through clean 50-micron filter to 5-10% of total system design flow rate. Use balance valve to adjust flow rate.
2. Replace 50-micron bag repeatedly as required to accomplish rough cleaning. This may require repeated bag replacement over an extended period of time.
3. Replace 50-micron bag with 25-micron oil-absorbent bag. Continue filtration until oil is removed from system to satisfaction of Owner. This too may require repeated bag replacement.
4. Replace 25-micron bag with 10-micron bag. Continue filtration until system is clean to satisfaction of Owner.
5. Rebalance flow rate through clean 10-micron filter to 5% of system design flow rate. Use balance valve to adjust flow rate. After adjustment lock memory stop on valve in place.
6. Inspect filter monthly throughout warranty period. Provide written log at filter indicating date of monthly inspection and filter bag replacement.
7. In no case shall filter pressure drop be allowed to exceed 10 PSI. Doing so will result in inadequate fluid flow and potential filter bag damage.

3.3 TEMPORARY UNIT

A. Hydronic Heating/Cooling Systems - Bag Type Bypass Filter

1. Bypass filter unit may be installed on temporary basis if indicated in project documents. If so, unit remains permanent property of installing Contractor.
2. Install temporary unit as described in paragraph above entitled *INSTALLATION* with the exception that flexible hoses may be used in lieu of permanent piping. Requirement for permanent structural support may also be deleted.
3. Requirement for shut-off valves for isolation of bypass piping from main system piping indicated in the paragraph *above entitled INSTALLATION* remains. Locate valves at tie-in points to mains for isolation of bypass piping from main system piping as if permanent filter unit was being installed. Provide nipple and cap at each valve.
4. Startup and maintenance requirements shall be as described in paragraph above entitled *"START-UP AND MAINTENANCE"* except filter unit may be removed after initial start-up and commissioning period. Unit shall not be removed until system is deemed clean to satisfaction of Owner.

END OF SECTION 232510

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 233100 - HVAC DUCTS

PART I - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Ducts and fittings.
2. Materials.
3. Sealants and gaskets.
4. Hangers and supports.

1.2 DEFINITIONS

A. Hydronic System: Non-potable water-based heat transfer system, excluding steam. Hydronic systems include heating hot water, chilled water, chilled beam and condenser water systems.

B. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.

C. Abbreviations:

1. >: Greater than.
2. <: Less than.
3. ≤: Less than or equal too.
4. #: Number.
5. %: Percent.
6. ACGIH: American Conference of Governmental Industrial Hygienists.
7. ASME: American Society of Mechanical Engineers.
8. ASTM: The American Society for Testing of Materials.
9. AWS: American Welding Society.
10. Dia.: Diameter.

11. E.g.: Exempli gratia “for example.”
12. Etc.: Et cetera “and other similar things.”
13. F: Degrees Fahrenheit.
14. F&S: Facilities and services.
15. FDA: Food and Drug Administration.
16. FPM: Feet per minute.
17. FSK: Foil skim kraft.
18. FT or ‘: Feet.
19. HVAC: Heating, Ventilating, and Air-conditioning.
20. IAQ: Indoor air quality.
21. I.e.: Id est “in other words.”
22. In or “: Inches.
23. MIG: Metal Inert Gas welding.
24. MSDS: Material safety data sheet.
25. NADCA: National Air Duct Cleaners Association.
26. NFPA: National Fire Protection Association
27. SMACNA: Sheet Metal and Air-conditioning Contractor’s National Association.
28. SP: Static pressure.
29. TIG: Tungsten Inert Gas welding.
30. UIS: The University of Illinois at Springfield.
31. UL: Underwriter’s Laboratories.
32. USDA: United States Department of Agriculture.
33. VAV: Variable air volume.
34. W.C.: Water column.

1.3 SUBMITTALS

- A. Submit shop drawings per Division 01 Section(s) – Shop Drawings, Product Data, and Samples.
- B. Provide manufacturer’s data and/or contractor data for the following:
 1. Fabrication and installation drawings.
 2. Schedule of duct systems including material of construction, gauge, pressure class, system class, seal class, leakage class, method of reinforcement, joint construction, fitting construction, and support methods, including details as appropriate.
 3. Manufactured duct (i.e. double wall duct, flexible duct).
 4. Turning vanes.
 5. Duct sealant and gasket materials.
 6. Duct leakage testing methods, apparatus, and apparatus certification signifying meter is in conformance with ASME requirements for fluid meters.

- 7. Upon completion of duct leakage testing, submit a minimum of six (6) copies of the signed report to the AE, indicating test apparatus used, results of the leakage test, and remedial work required to bring duct systems into compliance with approved leakage rates.
- 8. Submit shop drawings of ductwork for the entire facility. Drawings shall be to scale, double line, with duct sizes, locations, fittings, equipment, accessories and structural clearances shown. Do not install ductwork prior to approval of shop drawings by AE.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Promptly inspect shipments to ensure that ductwork is undamaged and complies with the specification.
- B. Protect ductwork against damage.
- C. Protect ductwork by storing inside or by storing in durable, waterproof, above ground packaging. Do not store material on grade. Protect ductwork from dirt, dust, construction debris and foreign material. Where end caps/packaging are provided, take precautions so caps/packaging remain in place and free from damage.
- D. Offsite storage agreements do not relieve the contractor from using proper storage techniques.

PART 2 - PRODUCTS

2.1 GENERAL DUCTWORK FABRICATION REQUIREMENTS

- A. Ductwork shall be constructed to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.
- B. Use material, weight, thickness, gauge, construction, and support and installation methods as outlined in the above-listed SMACNA publications. Minimum gauge of galvanized steel rectangular supply, return and exhaust ductwork shall be 24-gauge.
- C. Duct board is **not** allowed.
- D. Mixed Air Ductwork Requirements: Ductwork carrying mixed air shall be of sufficient length prior to entering heating coils to prevent stratification.
- E. Use products which conform to NFPA-90A, possessing a flame spread index of not over 25 and a smoke developed rating of not over 50.
- F. Duct liner: Liners shall not be used.
- G. Duct Velocities and Pressure Class Requirements: Sizing and pressure classes of ductwork for comfort heating and cooling systems, laboratory hazardous exhaust systems, toilet exhaust systems and grease exhaust systems shall be based on the following table. Sizing and pressure classes of ductwork for other types of systems shall be based on SMACNA, ASHRAE, ACGIH and engineering "best practices".

Description	High Pressure SP > 6 inches w.c.	Medium Pressure 2 inches w.c. < SP ≤ 6 inches w.c.	Low Pressure SP ≤ 2 inches w.c.
Heating and Cooling - fpm	2,400 < Velocity < 3,500	1,500 < Velocity < 2400	Mains < 1,500 Branches < 1,200 After Term. < 1,200 Branch to Individual Grille/Diffuser < 600
Laboratory Hazardous Exhausts (such as fume hoods, etc.) - fpm	2,000 < Velocity < 3,000	1,000 < Velocity < 2,000	

Toilet Exhausts - fpm		1,000 < Velocity < 1,500	Velocity < 900
Kitchen Hood Exhausts - fpm		1,500 < Velocity < 2,500	

- G. Duct sizes indicated on drawings are net inside dimensions.
- H. Duct Sizes Not Indicated: Where size for a duct segment is not indicated:
 - 1. The duct segment size shall be equal to the largest duct segment to which it is connected.
 - 2. Transition to a smaller size shall occur on the side of the fitting where the smaller size is indicated.
- I. Takeoffs: Takeoffs shall be designed and constructed as follows:
 - 1. Rectangular to rectangular: Use 150% to 200% free area take off from main to branch duct.
 - 2. Round to 45-degree conical wye or round to 90-degree conical wye: Use a typical branch coefficient of 0.45 or less.
 - 3. Round to 45-degree "T" or Wye: Use a typical branch coefficient of 0.45 or less.
 - 4. Round to 60-degree "T" or Wye: Use a typical branch coefficient of 0.65 or less.
 - 5. 90-degree "T" or Wye is not allowed.
- J. Elbows:
 - 1. Elbows for Rectangular Ducts:
 - a. Use radius throat, radius heel elbows with a minimum centerline radius to width ratio of 1.5. Where 1.5 radius elbows will not fit, use 1.0 radius elbows with "radius proportional" splitter vanes permanently installed within. Splitter vanes shall be installed per SMACNA and manufacturer's recommendations.
 - b. Where radius elbows will not fit, provide square elbows with turning vanes. Turning vanes shall be installed per SMACNA and manufacturer's recommendations.
 - c. Square throat, radius heel elbows are not allowed.
 - 2. Elbows for Round Ducts:
 - a. Use radius elbows with a minimum centerline radius to diameter ratio of 1.5. Where 1.5 radius elbows do not fit, use 1.0 radius elbows.
- K. Transitions: Limit transition angles (for each side) to 15-degrees diverging and 30-degrees converging.
- L. Flex Connections:
 - 1. Connections to inlet and discharge openings of fans shall be made with a section of at least 1/16-inch thick neoprene coated fiberglass fabric. Flex connections shall not be less than 4-inch long and shall have at least 1-inch of slack. Connections shall have angle frames at each end for rectangular ducts, and metal tension bands at each end for round ducts. Flex connections shall be installed to allow for easy replacement and shall be installed on straight duct sections, not on transitional fittings or tapers.
 - 2. Connections to units that have fans internally isolated within the unit housing do not require flex connections unless required for noise and vibration purposes.
- M. Additional Pressure Class Requirements:
 - 1. VAV: For coordination purposes, unless otherwise indicated, the pressure class for VAV system ductwork upstream of the air terminal devices shall be equal to or greater than the

static pressure at the fan outlet but not less than 4-inches w.c. for the fan discharge side ductwork.

2. Constant Volume: For coordination purposes, unless otherwise indicated, pressure class for Constant Volume system ductwork shall be equal to the external static pressure (fan outlet or discharge pressure minus associated unit internal component pressure drop), but no less than 2-inches w.c.
3. Minimum allowable pressure class for low pressure ductwork is 2-inches w.c.
- N. Seal Class: Ductwork, including low pressure ductwork, shall be SMACNA Seal Class A with joints, seams and wall penetrations sealed.
- O. Leakage Class: Rectangular ductwork shall be SMACNA Leakage Class 6 and round ductwork shall be SMACNA Leakage Class 3.
- P. Seams: Longitudinal seams shall be "Pittsburgh" style. Snap-lock seams are not allowed.
- Q. Crossbreak or bead rectangular ductwork. Crossbreaks shall be "out" on positive pressure duct and "in" on negative pressure ducts.
- R. Bolts and Fasteners: Carbon steel, zinc coated per ASTM-A153 for galvanized steel ducts and stainless steel for aluminum and stainless steel ducts.
- S. Welding Materials: Refer to SMACNA – Sheet Metal Welding Guide.

2.2 DUCTWORK MATERIALS

A. Flexible Duct:

5. Shall be factory fabricated, listed and labeled as a UL-181 Class 1 air duct, and shall comply with NFPA-90A and NFPA-90B.
6. Flame spread shall be 25 or less and smoke developed shall be 50 or less.
7. Minimum Service Temperatures and Pressures: -20 to 250-F; 10-inches w.c. positive; 10-inches w.c. negative through 12" dia., 5-inches w.c. negative - 14" and 16" dia., 1-inch w.c. negative - 18" and 20" dia.
8. Rated Velocity: 5,500-fpm.
9. Inner Liner: Liner shall be nonmetallic type composed of polyester film, polyethylene film, nylon film or woven and coated fiberglass fabric liner mechanically locked without adhesives to corrosion resistant galvanized steel wire helix.
10. Insulation: Fiberglass blanket – 3/4-pound, factory wrapped, minimum 1-1/2" thick.
11. Vapor Barrier: Barrier shall have a permeance of not over 0.1-perm and shall be fiberglass reinforced aluminum material or polyethylene.
12. Usage: Connections to air inlets and outlets. Maximum allowable length is 7'-0". Flexible duct is **not** permitted in medium and high pressure duct systems.
13. Flexible Duct Connectors:
 - a. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18-inches (75 through 460-mm), to suit duct size.
14. Installation:
 - a. Shorten and reinstall sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain centerline radius to diameter ratio of 1.5.
 - b. Support flexible duct with pre-manufactured hangers.
 - c. To attach flexible duct to hard duct and air-device (typical of 2), tape the inner liner to the hard duct / air device then attach with two stainless-steel clamp flexible duct connectors,

one for the inner liner and one for the vapor barrier. Fold the vapor barrier inside itself so it has neat edges prior to tie wrapping.

- d. Flexible duct elbows; Provide radius forming elbow.
 - i. Basis of Design: Thermaflex / FlexFlow or comparable product by:
 1. Titus.
 2. Thermoflo.
- B. Galvanized Steel Rectangular Duct – Single Wall:
1. Material: Ductwork and reinforcements shall be ASTM-A653, A924 mill galvanized steel. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM-A90. Provide “Paint Grip” finish or galvalume sheet metal for ductwork that will be painted.
 2. Reinforcement: Reinforcement shall be external to the duct except that tie rods may be used with the following limitations:
 - a. Conform to SMACNA requirements.
 - b. Ducts must be over 18” wide and duct dimensions must be increased 2” in one dimension (height or width) for each row of tie rods installed.
 - c. Tie rods must not exceed 1/2” in diameter.
 - d. Manufacturer of tie rod systems must certify pressure classifications of various arrangements. This information shall be included in the shop drawings.
 3. Joints: Transverse joint systems shall be a manufactured product that has been tested for conformance with Section VII of SMACNA-1035 – HVAC Duct Construction Standards – Metal and Flexible for sheet and joint deflection at the required pressure class:
 - a. General: Apply sealant to inside corners. Holes at corners are unacceptable.
 - b. Slide-On Flanged Transverse Joint Systems:
 - i. Basis of Design: Ductmate / ‘25’/35’/45’ or comparable product by:
 - i. Nexus
 - ii. MEZ
 - iii. WDCI
 - c. Formed-On Flanged Transverse Joint Systems:
 - i. Basis of Design:
 3. Lockformer / TDC
 4. Lockformer / TDF
 5. Sheet Metal Connectors / TDC or comparable products by:
 - a. United McGill
 - ii. Manufacturers other than those specified above shall submit test data, and fabrication standards, and receive AE approval before fabrication begins.
 4. Exception: Galvanized steel round duct may be substituted for galvanized steel rectangular duct where approved by AE. The round duct shall meet the standards set forth in this specification. The round duct shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with other trades prior to installation.

C. Galvanized Steel Round Duct:

1. Material: Ductwork and reinforcements shall be ASTM-A653, A924 mill galvanized steel. Galvanized coating to be 1.25-ounces per square foot, both sides of sheet, G90 in accordance with ASTM-A90. Provide "Paint Grip" finish or galvalume sheet metal for ductwork that will be painted.
2. Reinforcement: Reinforcement shall be external to the duct. Internal reinforcement is not allowed. Flat oval duct shall be reinforced the same as rectangular duct of similar size.
3. Construction: Machine-formed, round and/or flat oval spiral lock seam duct. Longitudinal or snap lock seams are not allowed. Duct shall be single wall or double wall type. Liner in double wall duct shall be solid and annular space between inner liner and outer duct shall be filled with 1" thick fiberglass insulation.
4. Manufacturers:
 - a. Ajax
 - b. Lindab
 - c. Semco, Inc.
 - d. United McGill
 - e. Sheet Metal Connectors
 - f. United Sheet Metal
5. Joints: Slip type connection with a 2" minimum insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
6. Secure joints with at least three (3) sheet metal screws before sealing.
7. Ducts and fittings larger than 36" dia. shall have flanged connections.

D. Stainless Steel Welded Duct:

- a. Laboratory Hazardous Exhaust (such as fume hoods, etc.):
 - i. Laboratory hazardous exhaust ducts shall typically be round. Ducts may be rectangular only where installation of round duct is not feasible.
 - ii. Laboratory hazardous exhaust ductwork shall be type 316L stainless steel.
 - iii. Laboratory hazardous exhaust ducts 10" and smaller and rectangular equivalent shall be 18-gauge minimum. Round ducts 12" and larger and rectangular equivalent shall be 16-gauge minimum.
- b. Cage Washer and Autoclave Exhaust:
 - i. Requirements for cage washer and autoclave exhaust ductwork are same as laboratory hazardous exhaust except material shall be type 304L stainless steel.
- c. Kitchen Dishwasher Exhaust:
 - i. Requirements for kitchen and dishwasher exhaust ductwork shall be same as cage washer and autoclave exhaust.
- d. Construction and Joints:
 - i. Stainless steel exhaust ductwork shall have continuously welded joints and seams. Joints shall be liquid tight. Note: Round duct joints shall be butt-welded.
 - ii. Welds shall conform to AWS D9.1M. Welds shall be Gas Tungsten Arc Weld (TIG) or Gas Metal Arc Weld (MIG) type. Filler metal shall conform to AWS-A5.9

or A5.22 and be AWS Classification ER308L or ER308LSi with a carbon content of not over 0.03%.

- iii. Exposed duct shall be wire brushed and polished to #3 finish. Concealed duct shall have #2 or #2D mill finish.
- iv. Supports shall not penetrate duct surfaces.

e. Reinforcement and supports:

- i. Reinforcement and supports shall be same material as duct.
- ii. Reinforcement and supports shall be external to duct. Internal reinforcement not allowed. Reinforcement and supports shall not penetrate duct surfaces.

- f. Turning vanes, dampers or other obstructions not allowed in laboratory hazardous, cage washer and autoclave, or kitchen dishwasher exhaust ductwork.

E. Black Steel Welded Duct:

1. Material: Ductwork and reinforcements shall be black steel, 16-gauge minimum.
2. Reinforcement: Reinforcement shall be external to the duct. Internal reinforcement is not allowed.
3. Construction and Joints: Ductwork shall have continuously welded joints and seams (Joints shall also be liquid tight.).
4. Supports shall not penetrate duct surfaces.
5. Note: Turning vanes and dampers are not allowed in kitchen hood exhaust duct.

2.3 DUCTWORK SEALANTS AND GASKETS

A. Sealant:

1. UL Classified sealant as compounded specifically for sealing joint and seam in ductwork shall be used.
 - a. Manufacturers:
 - i. Hardcast, United McGill
 - ii. Mon-Eco Industries
 - iii. H. B. Fuller/Foster
2. Duct tapes are not allowed.
3. Select sealants as recommended by manufacturer for specific application.
4. Submit sealant manufacturer's data sheets including performance data, pressure ratings, surface burning characteristics data, and manufacturer's detailed installation instructions.
5. Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork and before startup of air handling systems.

B. Gaskets:

1. Use Butyl or polymer based tape.
 - a. Basis of Design:
 - i. Ductmate / 440,
 - ii. Ventfabrics / Ventlok No. 797 or 799 in flanged joints
 - iii. Or comparable product.

2. Gasket material shall be FDA or USDA approved.

C. Exterior Sealants and Gaskets:

1. Same as for interior ducts, but use only products rated from -20 to 200-F and 2,000-hour minimum ultra-violet resistance per ASTM-G53.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Ductwork and equipment shall be free of kinks, dents and defects before and after installation.
- B. Cleaning: Properly clean components internally and externally prior to assembly.
- C. Verify dimensions on site, making field measurements and drawings necessary for fabrication and erection. Check plans showing work of other trades and consult with AE in the event of interferences.
- D. During construction, provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering duct system.
- E. Provide openings in ducts for thermometers and controllers.
- F. Provide openings in ducts for test and balance work.
- G. Do not install ducts and other equipment above electrical switchboards or panelboards.
- H. Where two (2) dissimilar metals meet, the joint shall be installed in such a manner that ducts do not contact each other by using a proper seal or compound.
- I. Repair tears in duct insulation.
- J. Install manual volume dampers in branch supply, return and exhaust ducts so that the air devices can be adjusted.
- K. At manual volume dampers, provide 1" stand-offs on operators when ductwork is insulated.
- L. Insulate air terminal unit reheat coils. Seal insulation tight in order to form a tight vapor barrier.
- M. Exterior Ducts: Seal exterior ducts watertight. Exterior ductwork shall be round.
- N. Duct Support: Support duct systems in accordance with SMACNA-1035 – HVAC Duct Construction Standards – Metal and Flexible.
- O. Stainless Steel Duct Hangers: Hangers for stainless steel duct shall be 304L-stainless or galvanized steel. Painted or plain steel supports are not allowed.
- P. Cable or Strap Hangers: Main runs of ductwork shall not be supported by cable or strap hangers. Only 12" dia. and less dedicated branch runs can be supported by cable or strap hangers.
- Q. Riser Support: Vertical duct risers shall be supported at each floor.
- R. Sleeves: At duct penetrations thru mechanical room floors, provide metal sleeves that are 6" high above floor in order to prevent moisture from dripping to floors below.
- S. Where supply diffusers are located with backs exposed to unconditioned plenums, ventilated attics, etc., insulate backs with 3/4" thick, flexible fiberglass wrap with FSK jacket.

3.2 LABORATORY HAZARDOUS AND KITCHEN DISHWASHER HOOD / CAGE WASHER EXHAUST DUCT INSTALLATION

- A. Ducts shall maintain the maximum possible pitch toward their inlets unless a different drainage location is indicated on the drawings. If at least 1/8" per foot pitch cannot be maintained, notify PSC before installing duct or other items with which duct may conflict.

3.3 KITCHEN HOOD EXHAUST DUCT INSTALLATION

- A. Install ductwork, including access doors in accordance with NFPA-96.
- B. Provide rated insulation or rated enclosure as required by code.
- C. Rated insulation or rated enclosure shall be removable at each access door.
- D. Construct grease tight access doors of the same material and thickness as the duct and as large as possible, up to 24-inches maximum dimension. Locate on sides of duct for ease of inspection and cleaning at each change in direction, every 8 to 10-lineal feet of horizontal duct, and not less than 1-1/2-inches from the bottom of the duct.
- E. Install duct without forming dips or traps which might collect residue.

3.4 CLEANING

- A. Remove dirt and foreign matter from the entire duct system and clean diffusers, registers, grilles and the inside of air handling units before operating fans.
- B. Cleaning Agents: Use only non-hazardous, non-toxic cleaning agents and materials. Provide MSDS sheets.
- C. Clean in accordance with National Air Duct Cleaners Association (NADCA).

3.5 LEAKAGE TESTING

- A. Test medium and high pressure and select sections of low pressure (described below) ductwork in accordance with test methods described in Section 5 of the SMACNA HVAC Air Duct Leakage Test Manual. Test low pressure supply air and return air ductwork located in attics and other unconditioned spaces; outside air and relief air ductwork; and ductwork to and from energy/heat recovery equipment. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable.
- B. Ductwork that is not required to be tested shall still meet the seal and leakage class requirements of this specification.
- C. Maximum allowable leakage shall be calculated by the contractor based on Figure 4-1 in the SMACNA HVAC Air Duct Leakage Test Manual. Contractor is responsible for duct square footage calculations and other calculations necessary to establish maximum allowable leakage.
- D. Test methods and calculations shall comply with the requirements set forth in the SMACNA HVAC Air Duct Leakage Test Manual.
- E. If excessive air leakage is found, locate leaks, repair the duct in the area of the leak, seal the duct, and retest.
- F. Totaling leakage from several sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
- G. If leaks cause discernible noise at a distance of 3-feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
- H. Submit a signed report to the AE, indicating test apparatus used, results of the leakage test, and remedial work required to bring duct systems into compliance with specified leakage rates.

3.6 DUCTWORK APPLICATION SCHEDULE

USAGE	MATERIAL
Supply Air Duct	Galvanized Steel
Return Air Duct	Galvanized Steel
Relief Air Duct	Galvanized Steel
General Exhaust Air Duct	Galvanized Steel

USAGE	MATERIAL
Toilet Exhaust Air Duct	Galvanized Steel
Hazardous Exhaust Duct (e.g. fume hoods, etc.)	316L Stainless Steel- Welded
Kitchen Hood Exhaust Duct-Concealed	Black Steel-Welded
Kitchen Hood Exhaust Duct-Exposed	304L Stainless Steel- Welded
Dishwasher Hood and Cage Washer Exhaust Duct-Concealed and Exposed	304L Stainless Steel- Welded

END OF SECTION 233100

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 233300 - AIR DUCT ACCESSORIES

PART I - GENERAL

1.1 SUBMITTALS

A. Product Data

1. Submit Manufacturer's technical product data and installation instructions for each: Inlet and Outlet component, blower, motor, flexible connection, all sealant and gasketing materials, products and accessories.

B. Shop Drawings:

1. Submit shop drawings of all Inlet and Outlet models for entire facility for approval prior to production. Do not release units for production prior to approval of shop drawings by the AE and Owner.

PART 2 - PRODUCTS

2.1 LOUVERS

- A. The General Contractor shall provide louvers.
- B. Blank-off panels on unused portion of louver shall be 2-inch thick insulated panels fabricated of minimum 22-gauge galvanized steel on both surfaces. Insulation shall be rigid type with minimum R-value of 10. Panels shall be reinforced with minimum 20 gauge steel stiffeners.

2.2 BIRD SCREENS

- A. Bird screens shall be provided by the General Contractor.

2.3 AIR MIXING DEVICES

- A. Acceptable Manufacturer: Blender Products, Inc]
- B. Units shall be not less than .08-inch aluminum of all welded construction.
- C. Units shall be completely fixed devices capable of providing mixed air temperatures within 6 degrees F of theoretical values.

2.4 PRESSURE CLASS

- A. VAV: For coordination purposes, unless otherwise indicated, the pressure class for VAV system ductwork upstream of the air terminal devices shall be equal to or greater than the static pressure at the fan outlet but not less than 4 inches w.g. for the discharge side ductwork.
- B. Constant Volume: For coordination purposes, unless otherwise indicated, pressure class for Constant Volume system ductwork shall be equal to the external static pressure (fan outlet or discharge pressure minus associated unit internal component pressure drop).

2.5 SUPPORT

- A. Accessories and associated components tied to ductwork shall be supported or suspended in like manner as the connected air handling ductwork.

2.6 GALVANIZED SHEET STEEL

- A. G90: First quality, lock former quality (LFQ), cold rolled, open hearth soft steel sheet capable of double seaming without fracture, ASTM A924 (formerly ASTM A525) or ASTM A653 (formerly ASTM A527). Galvanized coating shall be G90. G90 means the total amount of zinc on both sides is 0.90-oz/sq.ft. (0.45 oz/sq.ft per side).

- B. Painting: Use G90 Galvaneal or Zincgrip coating where painting is specified.

2.7 UNIT SEALANT AND GASKETING

A. Sealant:

1. UL Classified sealant as compounded specifically for sealing joint and seam in ductwork. Acceptable manufacturers are Hardcast, United McGill, Mon-Eco Industries or H.B. Fuller/Foster.
2. Duct tapes are not allowed.
3. Select sealant as recommended by manufacturer for specific application.
4. Submit sealant manufacturer's data sheets including performance data, pressure ratings, surface burning characteristics data, and manufacturer's detailed installation instructions.

B. Gaskets:

1. Butyl or polymer based tape similar to Ductmate 440, Venfabrics Ventlok No. 797 or 799 in flanged joints.
2. Gasket material shall be FDA or USDA approved.

2.8 ACOUSTICAL ENCLOSURE

- A. Enclosure: Inner layer shall be a 2 inch thick minimum layer of 3 psf glass or mineral fiber similar to type R insulation where specified in Division 23 for wall construction. Outer layer shall consist of 2 layers of 5/8 in. thick sheet rock with staggered seams, attached to sheet metal studs which are attached to structure not ductwork.

2.9 SILENCERS

- A. All silencer ratings shall be determined in accordance with the ASTM E-477-99 test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.
- B. All silencers shall withstand change(s) in system air pressure without "oil canning" and shall be designed to net reduce sound, i.e., self-generated noise must be accounted for in selections to meet intent.
- C. Submittals shall include necessary calculations meeting schedule and design requirements.
- D. Straight or Elbow Silencer
 1. All silencers shall be factory fabricated by the same manufacturer, except that "No-Loss" silencers (thicker than normal double-wall ducts) may be Contractor fabricated.
 2. Duct silencers shall have length, air pressure drop, and self-generated sound ratings not to exceed the values scheduled on the drawings. Dynamic insertion ratings shall not be less than those scheduled on the drawings. Silencer inlet and outlet dimensions must match the sizes on the drawings. Transitions are not acceptable unless shown on the drawings.
 3. All silencer ratings shall be determined in accordance with the ASTM E-477-99 test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.
 4. Silencers shall be constructed of galvanized steel, have 26 gauge minimum perforated interior (22 gauge for transitional silencers), be able to withstand 8" of positive and 4" of negative pressure, and shall have inorganic, bacteria, and fungus resistant glass fiber filler with not less than 5% compression. Silencers shall meet SMACNA standards for the duct pressure class specified.
 5. Tedlar shall completely separate the media from the airstream. No-media silencers shall not contain absorptive packing of any kind.

6. Silencers shall not exceed 25/50 flame spread/smoke developed per ASTM E84, NFPA 255, OR UL 723.
7. Acceptable Manufacturers: Vibro-Acoustics, VAW, United McGill, Semco, Ruskin Sound Control (Rink), AeroSonics, Dynasonics. All silencers shall be by the same manufacturer.

2.10 PRESSURE RELIEF DOORS

- A. Similar to Ruskin Model PRD 18 for positive pressure applications and Ruskin Model ADHP-3 for negative pressure applications.
- B. Door and frames shall be 12-gauge galvanized steel with seal around door perimeter. Doors shall be double-wall and insulated, when installed in insulated ductwork.
- C. Doors shall open automatically to relieve excess pressure above set point and to close when pressure is reduced to less than 3-inches WG. Setting shall be adjustable from 3-inches to 8-inches WG.

2.11 INSTRUMENT TEST HOLES

- A. Acceptable Manufacturers: Ventlok 699 (up to 1-inch insulation thickness) or Ventlok 699-2 (over 1-inch insulation thickness)
- B. Use concave gaskets for round ductwork.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

- A. Provide all necessary means for delivery, storage and handling of all related materials and components for the AHU system(s) such that they be kept clean and void of all miscellaneous construction materials including but not limited to dust, dirt, fluids, and scrap materials.

3.2 EXAMINATION

- A. Damage or Defects: All steel and sheet metal for purposes, including but not limited to, framing and surfaces, shall be free of kinks, dents, scratches, stains etc. and shall not exhibit an absence of proper galvanizing or prepared finish before and after assembly.

3.3 FINISHES

- A. Responsibility: Installing Contractor shall be responsible for finishes, ensuring they are per approved Specifications. Relevant replacement of rejected component(s) shall be required. Components shall not be altered to appear as other than their respective original design and manufacture as approved by the AE.

3.4 SOURCE QUALITY CONTROL

- A. Responsibility: Installing Contractor shall be responsible for verifying finishes for received materials, ensuring finishes are per approved specifications and have not been altered to appear as other than their respective original design and manufacture as approved by the AE.

3.5 CONSTRUCTION IAQ MANAGEMENT PLAN

- A. See *Section 01 35 46 – Indoor Air Quality Procedures* for related installation, protection, replacement, flush-out and testing requirements.

3.6 INSTALLATION

- A. Craftsmanship: Install components so that interior joint surfaces are smooth.
- B. See also Design Criteria: Provide transitions where different size or different shape connections are required between ductwork segments and Inlets and \ or Outlets. Unless otherwise indicated and hard duct connections are required, make diverging transitions with a maximum angle of 15

degrees per side (or 30 degrees total diverging) and 25 degrees per side for converging transitions (or 50 degrees total converging).

- C. Install all components as specified by the manufacturer.
- D. All components shall be installed in a neat workmanlike manner.
- E. Support Requirements: All components shall be installed level (in the same dimensional plane) as per the drawings.
- F. Dissimilar Metals: Where two dissimilar metals meet, install joint in such a manner that metals do not contact each other by using a proper seal, sealant or compound
- G. Outside Air Intakes: Refer to *Section 23 37 00 – Air Outlets and Inlets*.
- H. Maximum Air Velocity: Dampers shall be selected such that air velocity through the damper shall not exceed 2/3 of the manufacturer's published maximum for the make and module used.
- I. Branch Duct Balancing Volume Control: Volume dampers in branch ducts larger than 18 inches in any direction shall be of multiple, opposed blade pattern
- J. Splitter Dampers: Splitter dampers or air extractors not allowed
- K. Electrical Centers: Do not install air-handling related equipment over electrical panelboards, switchgear, switchboards or motor control centers
- L. Installation of Other Equipment: Install all motor operated dampers and connect to or install all equipment furnished by others. Provide all necessary blank-off plates or transitions to facilitate control dampers as specified in *Section 23 09 13.43 – Control Dampers*.
- M. Sealing Requirements: Seams and joint-sealing requirements shall meet SMACNA Class A.
- N. Mechanical Support: Support air handling related equipment with removable angles or channels and fasteners. Make all connections to equipment including equipment furnished by others. Secure frames with gaskets, nuts, bolts and washers.
- O. Protection: All air handling related equipment shall be protected with fabricated end caps for "end of the day" runs to prevent dirt or moisture contamination of the unit(s) until components are permanently attached.
- P. TURNING VANES
 - 1. Install turning vanes as shown on Drawings and for all rectangular square throat elbows unless otherwise indicated. Do not provide turning vanes in transfer air ducts. Install turning vanes in accordance with SMACNA Standard and/or manufacturer's recommendations.
 - 2. Install turning vanes so that they are tangent to the airflow.
- Q. FLASHINGS
 - 1. Install counter flashings were shown on Drawings. Install in accordance with SMACNA recommendations.
- R. SOUND ATTENUATING DEVICES
 - 1. Install sound attenuating devices as indicated on the Drawings and/or as scheduled.
 - 2. For modular installation of sound attenuators, install galvanized steel holding frame, gaskets, seals, supports and fasteners all in accordance with the manufacturer's recommendations for multiple unit installation.
- S. LOUVERS
 - 1. Provide insulated metal panel on unused portion of louver.
 - 2. General Contractor shall provide louvers.
- T. AIR MIXING DEVICES

1. Install air-mixing devices as indicated on the Drawings and/or as scheduled. The stacking of air mixing devices one above the other is not allowed. Install devices and associated duct connection in strict accordance with manufacturer's recommendations.

U. PRESSURE RELIEF DOOR

1. Install doors vertically where shown on the Drawings and in accordance with manufacturer's recommendations.

V. INSTRUMENT TEST HOLES

1. Provide instrument test holes at air entering and air leaving side of all internal air handling system components for static pressure differential (Delta P) or temperature differential (Delta T) measurements.
2. Provide instrument test holes at all ducts insulated with Type R insulation, as directed by TAB personnel, AE or as shown on Drawings.

3.7 REPAIR AND RE-INSTALLATION

- A. Surface Preparation: Prepare damaged surface by using power sanders or wire brushes to remove materials such as rust and paint.
- B. Paint: Use a galvanized paint specifically designed for painting of G90 galvanized surfaces where touch-up painting is required to prevent rusting of raw edges.
- C. Rework: Provide quality Work in like manner as initial installation, replacing all damaged components. Install materials conforming to the same criteria as outlined in these Specifications and conforming to SMACNA as previously described.

3.8 CLEANING

- A. Standards from National Air Duct Cleaners Association, NADCA for HVAC & Duct Systems shall be utilized for determining the need for and the extent of cleaning that will be required. These standards will be used to resolve any related issues.
- B. Fees: All fees related to testing, cleaning and repairs that are required to cover professional testing, cleaning and equipment repair to new conditions, if so jointly determined by the AE and the Owner as a result of implementing testing under the NADCA standards, shall be the Contractor's responsibility and shall not be passed on to UIS.
- C. Cleaning Agents: Use only non-hazardous non-toxic cleaning agents and materials. Provide MSDS cut sheets upon request.

END OF SECTION 233300

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 233400 - HVAC FANS

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Centrifugal Fans
 - 1. Housed
 - 2. Plenum
- B. Tubular In-line Fans
 - 1. Centrifugal
 - 2. Mixed Flow
- C. Laboratory Exhaust Fans
 - 1. High Plume, Induced Flow
 - 2. Tubular, Non-induction
- D. Laboratory Exhaust Fan Plenums
- E. Power Roof Exhausters

1.2 QUALITY ASSURANCE

- A. Fan shall bear *AMCA Certified Ratings Program Seal* for air performance and sound performance according to *AMCA Publication 311 and AMCA Publication 211*.
- B. Fan construction shall be compliant with *AMCA Standard 99*
- C. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and IOM.

1.3 SUBMITTALS

- A. Unit Data
 - 1. Fan Type, Class
 - 2. Wheel type, Size, Tip Speed
 - 3. Drive Arrangement, Discharge/Rotation
 - 4. Motor Type, Rated BHP, RPM, Electrical Characteristics
 - 5. Operating Weight
 - 6. Scaled Dimension Drawings
 - 7. Materials of Construction, Gauge/Thickness
 - a. Housing
 - b. Frame, structure
 - c. Wheel
 - d. Other components
 - 8. Finishes and Coatings
 - 9. Component Data
 - 10. Fan and component options as identified below

11. Fan accessories
 12. Fan special features
 - B. Performance data at specified operating point(s) including effect of factory-mounted airstream obstructions
 1. Airflow (CFM)
 2. Static Pressure (SP)
 3. Fan Speed (RPM)
 4. Fan Power (HP)
 5. Motor input frequency (Hz)
 - C. Additional data for laboratory exhaust fans
 1. Total airflow (CFM) including induction air
 2. Stack discharge velocity
 3. Plume height at specified wind velocity; supporting calculations
 - D. Fan Performance Curves
 1. Series of curves indicating relationship of CFM, SP, RPM, % efficiency and BHP for variable speed applications.
 2. Curves for design operating conditions
 - a. Initial design operating conditions
 - b. Future design operating conditions, as applicable
 - c. Impact of *wheel width controller* shall be incorporated, as applicable
 - E. Sound Power Levels, 8 octave
 - F. Unit Data for Exhaust Plenum and Components
 - G. Unit Data for Wheel Width / Pressure Independent Control
 - H. Installation and Operation Manual (IOM)
 - I. Structural Drawings
 1. Curb and/or structural support drawings
 2. Structural drawings for access platforms, ladders and railings
 - J. Factory and field fan balance reports upon request
- 1.4 DELIVERY, STORAGE AND HANDLING
- A. Fan and associated equipment shall be delivered to job site suitably packaged and protected for overland trucking using heavy-duty protective shrink-wrap plastic.
 - B. All items shipped loose shall be suitably secured in unit or on separate pallet similarly protected.
 - C. Fan shall be stored in clean, dry environment protected from exposure to dust, debris and fluids
 - D. Fan shall not be operated during construction phase of project unless specifically indicated otherwise in project documents and approved by Owner.
- 1.5 EXTRA STOCK
- A. For each belt driven fan, replacement set of matched belts shall be provided once proper belt length has been determined by TAB Contractor.

1.6 APPROVED MANUFACTURERS

- A. Standard Clean Air Applications
 - 1. Twin City Fan and Blower
 - 2. Chicago Blower Corporation
 - 3. New York Blower Company
 - 4. Greenheck Fan Corporation
 - 5. Loren Cook Company
 - 6. PennBarry
 - 7. Nortek Air Solutions
- B. Laboratory Exhaust Applications
 - 1. MK Plastics
 - 2. Plasticair, Inc.
 - 3. Greenheck Fan Corporation
 - 4. Loren Cook Company
- C. Power Roof Exhausters
 - 1. Greenheck Fan Corporation
 - 2. Loren Cook Company
 - 3. Pennbarry

1.9 WARRANTY

- A. Assembled unit shall be warranted by manufacturer to be free from defects in material and workmanship for period of one year from date of startup or 18 months from date of delivery whichever occurs first. Manufacturer shall repair or replace unit at no cost to Owner.
- B. Unit shall be warranted by manufacturer to provide specified performance for period of one year from date of startup. Manufacturer shall adjust, repair or replace unit at no cost to Owner.

PART 2 – PRODUCTS

2.1 CENTRIFUGAL FANS – GENERAL REQUIREMENTS

- A. General
 - 1. Fan assembly shall be furnished complete with motors, wheels, drive assemblies, bearings, coatings and accessories as specified herein.
 - a. Power roof exhausters specified separately
 - 2. Fans shall be industrial grade Class 2 or Class 3 as required for application. Fan RPM at design operating point shall not exceed 80% of maximum rated RPM for fan class. Fan class shall be adequate to ensure compliance with such limitation.
 - 3. Fan housing and bearing supports shall be constructed of welded structural members and shall incorporate structural base as applicable.
 - 4. All non-galvanized steel components including hardware other than stainless steel shall be primed and painted prior to assembly.

5. Fans located outdoors shall be provided with powder coat finish with UV protectant topcoat on all exposed steel components. Any scratches or defects in coating shall be touched up after installation per manufactures recommendations.
6. Fans shall be direct drive unless indicated otherwise in project documents.
 - a. Notable exceptions, following shall be belt-driven:
 - 1) Tubular In-line fans
 - 2) Laboratory in-line exhausters 3 HP and smaller
 - 3) DWDI (double width double inlet) fans
 - 4) SWSI fans only if available fan selections require operation outside approved motor frequency range.
7. Fans complete with accessories and optional features shall be factory assembled.

B. Fan Options

1. Fan and component options from list below shall be provided as specified or indicated in schedule.
 - a. Application
 - 1) General purpose clean air
 - 2) Corrosive vapors
 - 3) Combustible vapors
 - 4) Other contaminated exhaust
 - b. Fan/housing type
 - 1) General purpose clean air
 - (a) Single width single inlet (SWSI)
 - (b) Double width double inlet (DWDI)
 - (c) Plenum
 - (d) Tubular in-line
 - 2) Laboratory/contaminated exhaust
 - (a) High plume, induced flow
 - i. Tubular in-line
 - ii. SWSI centrifugal
 - (b) Standard, non-induced flow
 - i. Tubular in-line
 - c. Fan wheel type
 - 1) Centrifugal
 - 2) Mixed flow
 - d. Fan drive type
 - 1) Direct drive
 - 2) Belt-driven

- e. Fan configuration
 - 1) Arrangement
 - 2) Rotation
 - 2) Motor location
 - f. Fan and housing materials
 - 1) Steel
 - 2) Aluminum
 - 3) Stainless steel
 - 4) FRP
 - g. Spark resistant construction
 - 1) AMCA type A
 - 2) AMCA type B
 - 3) AMCA type C
 - h. Coating
 - 1) Primed and painted
 - 2) Powder coated
 - 3) Phenolic coated
- C. Accessory Options
1. All accessory options listed below shall be provided unless indicated otherwise in project documents
 - Outlet flange
 - a. Inlet flange
 - b. Hinged access door or bolted panel
 - c. Drain with NPT connection
 - d. Shaft seal
 - e. Totally enclosed shaft guard
 - f. Totally enclosed belt guard
 - g. Vibration isolators
 - 1) Spring, per manufacturer's recommendation
 - 2) Neoprene, per manufacturer's recommendation
 - 3) Inertia base, per manufacturer's recommendation
 - h. Thrust restraints, as applicable
 - i. Fan guard, for exposed fans only
 - j. Weather hood, outdoor applications only
 - k. Lifting lugs

D. Special Feature Options

1. Wheel Width / Pressure Independent Control Device
2. Other special features as specified or indicated in schedule

E. Selection

1. Fan shall be selected to avoid surge and yield stable operation at all operating speeds.
2. Fan shall be selected to operate at or near peak efficiency at design operating point.
3. Fan performance data shall include effect of any factory-mounted airstream obstructions such as protective screens and guards.
4. Fan performance shall include impact of any applicable "system effect".
5. Fan/motor combination shall be capable of providing design performance (100% CFM at design operating conditions) **without exceeding 90% nameplate amperage**.

Note to Contractor and Manufacturer: Do not overlook 90% nameplate amp limit. It will be factory and/or field tested per specifications.

6. VFD size/selection shall be based upon 100% of increased motor HP and associated 100% nameplate amperage. Contractor shall confirm with Fan Manufacturer that scheduled HP satisfies this requirement.
7. Traditional non-overloading selection is not necessarily required when fan is served by variable speed drive. VFD shall be configured and adjusted to prevent overloading.
8. If fan selection is based upon two different operating conditions (i.e. initial design conditions and future design conditions) selection shall yield optimized performance at both conditions to greatest degree possible.
 - a. In such case, fan selection shall comply with all requirements listed above for both operating conditions.

F. Component Requirements

1. Housing

- a. Metallic housing/scroll construction shall be continuous welded throughout. FRP housing shall be continuous molded. Housing shall be braced and supported by structural members to prevent vibration or pulsation. Housing shall incorporate structural base.
 - 1) Housing/scroll with lock seams or partially welded construction not acceptable.
- b. Fan inlet cone shall be fully streamlined, aerodynamically matched to wheel to ensure full loading of blades.
- c. Appropriate spark resistant construction shall be provided for applications with combustible vapors. Fans having spark resistant construction shall be electrically grounded.
- d. Appropriate corrosion resistant construction and/or coatings shall be provided for applications with corrosive vapors.
- e. Hinged access door with positive latch or access panel, bolted and gasketed, shall be provided for complete access to interior of fan unit for maintenance, repair or cleaning without removal of ductwork.

2. Fan wheel

- a. Fan wheel shall be airfoil, backward curved, backward inclined or mixed flow type with self-limiting horsepower characteristic. For metallic fans, blades shall be continuous

welded to back plate and shroud. Airfoil fan wheels shall be seal-welded construction. For FRP fans, fan wheel shall be one piece molded construction. Forward curved fan wheels not allowed. Radial blade fan wheels not allowed for services other than particulate handling.

3. Shaft

- a. Fan shaft shall be turned, ground, polished and ring gauged for accuracy. Shaft material shall be AISI 1040 or 1045 hot rolled steel for standard clean air applications. Shaft for laboratory exhaust applications shall be stainless steel unless indicated otherwise in schedule or project documents.
- b. Fan shaft shall be sized for first critical speed at least 1.43 times maximum speed.

4. Bearings

- a. Fan bearings shall be heavy duty grease lubricated anti-friction, ball or roller, self-aligning pillow block type fitted with external grease fittings.
- b. Fan bearings shall be selected for a minimum average bearing life (AFBMA L-10) of not less than 200,000-hrs at maximum cataloged operating speed.

5. Motor

- a. Motor shall be TEFC, 1,800 RPM synchronous speed unless indicated otherwise in schedule.
- b.
- c. Drive inefficiencies shall be incorporated into motor selection.
- d. For direct drive fan applications motor shaft and bearings shall be conservatively designed to support overhung load of fan.
- e. For belt-driven fan applications motor shaft and bearings shall be conservatively designed to support radial load of tightly tensioned belts.
- f. Motors for belt-driven applications shall be provided with heavy duty slide bases.

6. Drive

- a. See requirements regarding drive type in section above entitled *General*.
- b. Direct drive fans shall be rigidly mounted on motor drive shaft.
- c. Only if indicated in project documents, V-belt drive shall be utilized.
 - 1) Sheaves shall be cast iron construction. Sheaves and belts shall be selected for 150% of motor nameplate HP minimum.
 - 2) For applications with motor horsepower 3 HP or less V-belt sheaves may be fixed pitch or variable pitch. For variable pitched sheave applications, sheaves and belts shall be selected such that sheaves are adjusted near midpoint with fan operating at design conditions.
 - 3) For applications with motor horsepower 5 HP or larger V-belt sheaves shall be fixed pitch type.
 - 4) V-belt drives shall have two belts minimum except fractional HP applications may have one belt. Multiple belts shall be factory matched set.
- d. Only if indicated in project documents, flat synchronous belt drive shall be utilized. Sheaves and belts shall be selected for 150% motor nameplate HP.

7. Belt Guard
 - a. On belt-driven fans OSHA approved protective guard shall be provided for rotating devices including but not limited to shafts, belts and sheaves.
 - b. Guard shall be easily removable for replacement of belts and other maintenance procedures.
 - c. Guard shall be rigidly mounted to prevent vibration.
 - d. Rotational speed test openings with protective collars shall be provided at shaft locations.
 8. Weather Cover
 - a. For outdoor applications OSHA approved weather cover shall be provided in lieu of belt guard to protect motor and drive components from weather.
 - b. Weather cover shall provide personal protection from rotating devices including but not limited to shafts, belts and sheaves.
 - c. Weather cover shall be easily removable for replacement of belts and other maintenance procedures.
 - d. Weather cover shall be rigidly mounted to prevent vibration.
 9. Fan Guard
 - a. Fans with exposed or partially exposed wheels shall be fitted with protective screen enclosure.
 - b. Enclosure shall be sized and designed to yield no measurable system effect on fan performance.
 - c. Enclosure shall be constructed of expanded metal or heavy gauge wire screen. Enclosure shall incorporate structural elements as required for strength and rigidity.
 10. Vibration Isolators
 - a. Vibration isolation shall be provided with restrained spring, rubber-in-shear and/or neoprene pad isolators as recommended and selected by Manufacturer. Restrained spring type shall be provided as default if Manufacturer provides no specific recommendations.
 11. Thrust Restraints
 - a. Thrust restraints shall be provided by Manufacture as recommended and applicable to fan type.
- F. Factory Run Test / Balance
1. All fans shall be completely assembled and test run as a unit prior to shipment at all speeds throughout allowable RPM range for particular fan construction type.
 2. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3 balance quality grade G6.3.
 3. Balance readings shall be taken by electronic type equipment in the axial, vertical, and horizontal directions on each bearing. Records shall be maintained and written copy shall be available upon request.
 4. Maximum allowable fan vibration levels
 - a. Belt-driven fans: 0.15 in/sec peak velocity, filter in
 - b. Direct drive fans: 0.10 in/sec peak velocity, filter in

2.2 HOUSED CENTRIFUGAL FANS

- A. Housed centrifugal fans shall satisfy all requirements specified above in section 2.1 *CENTRIFUGAL FANS – GENERAL REQUIREMENTS*.
- B. Additional Requirements
 - 1. Housed centrifugal fans shall incorporate scroll housing with configuration and arrangement as indicated in schedule or as otherwise indicated in project documents.

2.3 PLENUM FANS

- A. Plenum fans shall satisfy all requirements specified above in section entitled *CENTRIFUGAL FANS – GENERAL REQUIREMENTS*.
- B. Additional Requirements
 - 1. Plenum fans shall be unhoused with welded frame and heavy gauge steel inlet plate.
 - 2. Plenum fans may be configured in “fan array”.
 - a. Individual fan(s) or fans in array shall be provided in size, number and configuration indicated on drawings.
 - 3. Dampers
 - a. Dedicated isolation damper shall be provided for each fan. With Owner approval dampers for fan arrays may be system powered (gravity) specifically designed for application. Otherwise, dampers shall be automated and shall comply with requirements of *Section 23 09 13.43 – CONTROL DAMPERS*.
 - b. Dampers shall be specifically designed and configured to yield negligible impact on fan performance.

2.4 TUBULAR IN-LINE FANS, CENTRIFUGAL AND MIXED FLOW

- A. Tubular in-line centrifugal and mixed flow fans shall satisfy all requirements specified above in section 2.1 *CENTRIFUGAL FANS – GENERAL REQUIREMENTS*.
- B. Additional Requirements
 - 1. Housing mounting brackets shall be provided to allow support in multiple horizontal and vertical housing configurations to facilitate optimized motor and access door placement.
 - 2. Continuous welded flanges shall be provided.
 - a. Companion flanges shall be provided for ducted applications.
 - 3. Fan guard(s) shall be provided for non-ducted applications.
 - 4. Oversized hinged access door shall be provided.
 - a. Bolted access door acceptable only if hinged door not available as standard option.
 - 5. Tubular fans shall be belt-driven unless indicated otherwise in project documents.
- C. Belt Driven
 - 1. Aerodynamically shaped inner housing shall be provided to isolate shaft, bearing and sheave from airstream.
 - 2. Inner housing shall incorporate gasketed cover and labyrinth seal to provide air tight enclosure.
 - 3. Inner housing shall accommodate convenient removal of sheave, shaft and bearings.

4. Belt tube shall be provided between inner drive housing and external fan housing to totally enclose belts within airstream. Tube shall be continuous welded both ends.
5. Heavy duty motor mounting bracket shall be provided.
6. OSHA approved belt guard shall enclose belt and motor drive sheave.
7. Mounting rails and spring, rubber-in-shear or neoprene vibration isolators shall be provided as recommended by manufacturer for application.

2.5 LABORATORY EXHAUST FANS – GENERAL REQUIREMENTS

- A. Laboratory exhaust fans shall satisfy all requirements specified above in section entitled *CENTRIFUGAL FANS – GENERAL REQUIREMENTS*.
- B. Additional Requirements
 1. Laboratory exhaust fans shall satisfy all requirements of *ANSI/AIHA Z9.5 – Standard for Laboratory Ventilation*.
 2. Laboratory exhaust fans shall be designed for outdoor installation, roof-mounted.
 3. Exhaust fan assembly shall be self-contained factory-fabricated. Fan assembly shall not be field fabricated system (e.g. utility set with fabricated stack) unless indicated as such in project documents.
 4. Laboratory exhausters shall be induced flow or non-induction type as required to satisfy exhaust dispersion requirements. Type shall be as indicated in schedule or on drawings.
 5. Laboratory exhaust fans shall be tubular in-line type or SWSI centrifugal type as indicated in schedule or on drawings.
 6. Tubular in-line fans shall satisfy following requirements:
 - a. Fan motor shall not exceed 3 HP.
 - b. Fan shall be in-line centrifugal type.
 - c. Fan shall be belt-driven.
 - b. Motor and belt drive components shall be replaceable without requiring fan impeller removal.
 - c. Motor and drive maintenance shall not require access to contaminated exhaust components.
 - d. Fan assembly shall be configured for direct mounting upon curb or plenum.
 7. SWSI centrifugal fans shall satisfy following requirements:
 - a. Fan shall be direct drive with impeller mounted directly on fan shaft.
 - 1) Fan shall be belt driven only if available fans require selection outside approved motor frequency range.
 - b. Fan shall be configured for mounting upon curb or platform with inlet duct connection to side of exhaust plenum.
 - c. SWSI fans have no motor HP limitations.
- C. Discharge Performance
 1. Fan shall, under all operating conditions, maintain minimum effective plume rise indicated in project documents.
 - a. Effective plume rise calculation shall be based upon current edition of *ASHRAE Laboratory Design Guide*, Equation 9-2.

2) Wind speed used in calculation shall be 27.5 MPH (1% annual mean extreme at University of Illinois Willard Airport).

- b. Per *ANSI/AIHA Z9.1* referenced above exhaust stack discharge velocity shall be 3,000 FPM minimum.
- c. Clarification: Discharge velocity = velocity of exhaust air as it leaves last element of exhaust system. Not to be confused with nozzle velocity.

D. Components

1. Housing and Discharge Stack

- a. Fan shall be configured with vertical upward discharge.
- b. Per *ANSI/AIHA Z 9.1* referenced above...
 - 1) Stack height of installed unit shall be 10 ft. minimum above adjacent roof level.
- c. Fan stack shall incorporate concentric discharge nozzle.
 - 1) Nozzle shall not utilize stack cap nor hinged cover.
- d. Fan nozzle shall be rated for 6000 FPM discharge air velocity minimum.
- e. Installed fan assembly shall be rated for 125 MPH wind velocity without guy wires or other structural support.
- f. Fan arrangement shall be as indicated in schedule or on drawings.
- g. Hinged or bolted access door shall be provided. Access door size and placement shall permit convenient access to fan impeller, motor, drives and bearings as applicable.
- h. All exposed fasteners and hardware shall be type 316 stainless steel construction.
- i. Drain with NPT connection shall be provided as applicable.
- j. Lifting lugs shall be provided.

2. Impeller

- a. Impeller shall be airfoil, backward curved or backward inclined centrifugal type or mixed flow type as scheduled or otherwise indicated in project documents.

3. Drive

- a. Direct drive fans shall have impeller firmly attached directly to motor shaft.
- b. Belt-driven fans shall have motor located outside exhaust airstream.
- c. Fan shaft shall be stainless steel unless indicated otherwise in project documents.
- d. Where required to prevent shut down of fan for lubrication, extended stainless steel lube lines shall be provided. Otherwise extended lube lines shall be avoided.

E. Materials of construction / surface treatment of components exposed to contaminated air stream shall be based upon service as follows:

1. Chemical fume exhaust, acidic

- a. Corrosion resistant materials
 - 1) Type 316 stainless steel
 - 2) FRP
 - 3) Phenolic coated

2. Noxious or toxic vapor exhaust
 - a. Materials appropriate for wash-down
 - 1) Same as chemical fume exhaust
 - 2) Epoxy coated also approved
3. Radioisotope fume exhaust
 - a. Materials appropriate for wash-down
 - 1) Same as noxious or toxic vapor exhaust
4. Biological exhaust system
 - a. Materials appropriate for wash-down
 - 3) Same as noxious or toxic vapor exhaust
 - 4) HEPA filtration may be required
5. Combustible vapor exhaust
 - a. Spark resistant construction
 - 1) AMCA type A
 - 2) AMCA type B
 - 3) AMCA type C
6. Perchloric acid exhaust
 - a. Special fan/system, not specified herein

2.6 HIGH PLUME EXHAUSTERS – INDUCED FLOW TYPE

- A. High plume induced flow exhaust fans shall satisfy all requirements specified above in section entitled *LABORATORY EXHAUST FANS – GENERAL REQUIREMENTS*.
 1. Induced flow exhaust fans shall incorporate high dilution nozzle and wind band.
 - (a) Air induction discharge nozzle shall be supplied by fan manufacturer, integral to fan body design
 2. Induced flow exhaust fans shall induce ambient air up to 200% at specified primary airflow.

2.7 TUBULAR CENTRIFUGAL EXHAUSTERS, NON-INDUCTION TYPE

- A. Tubular centrifugal exhausters shall satisfy all requirements specified above in section entitled *LABORATORY EXHAUST FANS – GENERAL REQUIREMENTS*.
 - 1) Fan shall be in-line centrifugal.
 - 2) Exhauster shall incorporate high velocity discharge cone, factory fabricated.
 - 3) Stack shall be extended as required to satisfy stack height requirements.
 - 4) Fan shall be configured for direct mounting upon curb or plenum.

2.8 POWER ROOF EXHAUSTERS

- A. Description
 1. Power roof exhauster shall be spun aluminum, roof mounted, direct driven centrifugal exhaust ventilator.
 - a. Fan shall be down-blast or up-blast as indicated in schedule.

B. Fan Selection

1. Fan shall be selected to avoid surge and yield stable operation at all operating speeds.
2. Fan shall be selected to operate at or near peak efficiency at design operating point.
3. Fan performance data shall include effect of any factory-mounted airstream obstructions such as protective screens and guards.

C. Housing

1. Motor cover, shroud, curb cap, and lower wind band shall be constructed of heavy gauge aluminum.
2. Components shall be bolted to a heavy aluminum support structure.
3. Aerodynamic aluminum inlet cone and baffle shall be provided for maximum performance and efficiency.
4. Top cap assembly shall provide weather protection for motor and drive components.
5. Removable access cover shall be provided with quick release fasteners.
6. Motor shall be separated from exhaust airstream, ventilated with outdoor air.
7. Curb cap base shall have continuously welded corners.
8. Integral conduit chase shall be provided through curb cap into motor compartment.
9. Unit shall bear engraved aluminum nameplate indicating design CFM and static pressure.

D. Wheel

1. Wheel shall be non-overloading centrifugal backward inclined.
2. Wheel shall be constructed of aluminum including machined cast aluminum hub.
3. Wheel shall be balanced in accordance with *AMCA Standard 204 – Balance Quality and Vibration Levels for Fans*.
4. Wheel shall mounted directly upon motor shaft.

E. Motor

1. Motor shall be NEMA design B, insulation class B, rated continuous duty, furnished at scheduled voltage, phase and enclosure.
2. Motor shall have heavy duty permanently lubricated sealed ball bearings conservatively designed for vertical direct drive fan application.
3. Motors $\frac{3}{4}$ HP and smaller shall be electronically commutated (EC) furnished with factory mounted potentiometer speed controller.
 - a. Unit shall be provided with disconnect switch, factory-mounted within enclosure.
 - b. Remotely located starter provided by others.
4. Motors 1 HP and larger shall be AC induction type, three phase, suitable for use with variable speed drive.
 - a. Disconnect switch provided by others.
 - b. Remotely located VFD provided by others.

F. Accessories

1. Bird screen shall be provided, factory mounted.
2. Hinged base with restraint cable shall be provided.

3. Motorized backdraft damper shall be provided, field installed.

G. Curb

1. Roof mounting curb shall be provided if scheduled or shown on drawings
2. Curb shall be 16 gauge stainless steel or .080" aluminum construction.
3. Curb shall place fan 18" minimum height above roof surface.
3. Curb shall be double wall metal construction with no exposed insulation.
4. Curb shall incorporate wood nailer and damper shelf.
5. Gasket shall be provided to ensure tight seal between fan and curb.

PART 3 - EXECUTION

3.1 General

A. Floor-supported Fans

1. Fan shall be placed upon and firmly anchored to steel reinforced concrete pad.
2. Pad shall be anchored into concrete floor.
3. Pad shall be 4" minimum thickness and shall extend 6" minimum beyond fan support frame on all sides.
4. Pad construction shall be coordinated with General Contractor.
5. Spring supported inertia base shall be provided if indicated in project documents.
 - a. Inertia base shall be steel construction with welded-in reinforcing bars and concrete ballast.
 - b. Inertia base dimensions, weight and spring design shall be sized by vibration isolator manufacturer.

B. Ceiling-suspended Fans

1. Adequately sized hanger rods and/or structure firmly attached to ceiling or structural steel shall be provided.
 - a. Support system shall provide restraint to limit movement of fan housing.
 - b. Thrust restraints shall be provided as required.

C. Roof-mounted Fans

1. Fan shall be firmly mounted upon enclosed and insulated roof curb or enclosed and insulated structural support system. Exposed structural support members not allowed.
2. Curb / support system shall be of adequate strength and rigidity to support full operating weight of unit.
3. Curb / support system shall place fan at 18" minimum height above roof surface.
4. 36" minimum clearance shall be provided between finished roof and open support structure.
5. Fan shall be anchored and self-supporting such that guy wires or cables not required.
6. Flashing shall be provided as shown on architectural drawings.
7. For power roof exhauster, motorized damper shall be properly located and firmly mounted within curb.
8. Continuous welded stainless steel cap shall be provided for curb, 16 gauge minimum.

9. Curb / enclosure shall be flashed into roofing system. Roof membrane termination and two piece flashing shall be provided as specified and detailed elsewhere within project documents.
 10. Roof curb or support system construction shall be coordinated with Installing Contractor as applicable.
- D. Field Balance
1. Field balance not required unless, if in judgment of AE or Owner, vibration level is deemed questionable or unacceptable. In such case, vibration analysis and balancing shall be performed by qualified technician as specified above in section entitled *Factory Run Test / Balance*.
 - a. Referenced section indicates maximum allowable fan vibration level as follows:
 - 1) Belt-driven fans: 0.15 in/sec peak velocity, filter in
 - 2) Direct drive fans: 0.10 in/sec peak velocity, filter in
- E. Startup
1. Prior to startup
 - a. Bearings shall be properly lubricated.
 - b. Belts shall be properly aligned and tensioned.
 - c. Fans shall be turned by hand to ensure free rotation.
 - d. Proper installation of electrical wiring/components and proper motor rotation shall be confirmed.
 - e. Proper operation of dampers shall be confirmed.

END OF SECTION 233400

This section of the *UIS Facilities Standards* establishes minimum requirements only.

It should not be used as a complete specification.

SECTION 233600 – AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Air terminal units, single duct

1.2 DEFINITIONS

A. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.

B. Abbreviations:

1. AHRI: Air-conditioning, heating, and refrigeration institute.
2. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers.
3. ANSI: American National Standards Institute.
4. BAS: Building Automation System.
5. CFM: Cubic feet per minute.
6. DDC: Direct Digital Control
7. Deg.: Degrees
8. Etc.: Et cetera “and other similar things”
9. F: Degrees Fahrenheit.
10. FPM: Feet per minute.
11. HVAC: Heating, Ventilating, and Air-conditioning
12. IN or “: Inches
13. NFPA: National Fire Protection Association
14. Pcf: Pounds per cubic foot

15. TAB: Testing, adjusting, and balancing
16. UIS: The University of Illinois at Springfield
17. UL: Underwriter's Laboratory
18. W.c.: Water column

1.1 QUALITY ASSURANCE

- A. Air coils shall be AHRI certified, assuring validity of published performance ratings.
- B. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and installation, operation, and maintenance manuals.

1.2 SUBMITTALS

- A. Product Data:
 1. Shop Drawings of product data indicating configuration, general assembly, access space required for service, and materials used in fabrication.
 2. Electronic or Printed Catalog performance ratings that indicate nominal inlet size, CFM, applicable static pressure at the inlet or discharge of terminal unit, and noise criteria with sound octave band and sound decibel test in accordance with AHRI-880, for the insulation lining selected.
 3. Leakage curves indicating inlet static pressure and actual tested leakage rates shall be submitted for non-standard or custom-built terminal units.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials shall meet or exceed applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 MANUFACTURERS

- A. The same manufacturer shall provide products supplied and/or installed under this Section.
- B. Manufacturers:
 1. Daikin.
 2. Enviro-Tec.
 3. Metalaire
 4. Nailor.
 5. Price.

2.3 GENERAL CONSTRUCTION

A. Casing:

1. Unit casing: Terminal unit casing shall be constructed of minimum 22-gauge galvanized steel.
2. Insulation: Insulation shall meet the requirements of UL181 and NFPA-90A and shall not support bacterial or fungal growth. Insulation shall be neatly installed with no rough edges to interrupt the smooth flow of air through the unit. Casing shall be insulated throughout its interior.
 - a. For general use applications in supply and return air systems; Provide a minimum 1-inch thick, 1.5-pcf density, closed cell, fiber-free insulation liner.
 - b. For wet, corrosive, or other applications such as outdoor air, exhaust air, mixed air, laboratories, natatoriums, showers, locker rooms, kitchens, etc.; Provide terminal unit casing of double-wall construction, internally insulated with a 1-inch thick, 1.9-pcf, glass fiber insulation to produce an R-value of 4.2 or greater. The interior liner shall be minimum 26-gauge metal of the type suitable for the application (galvanized steel, aluminum, stainless-steel, etc.).
2. Casing Leakage: Assembled units shall be constructed such that casing leakage does not exceed 1.0-percent of terminal unit rated airflow at 4-in-w.c. of inlet static pressure.

B. Damper:

1. Damper Leakage: Units shall be tested for inlet leakage with 4-in-w.c. static pressure imposed. The maximum percent leakage from tests shall be reported. The following table provides the maximum allowable damper leakage for the various size diameter inlets at 4 inches w.g. differential pressure.

INLET DIAMETER (INCHES)	MAXIMUM ALLOWABLE CFM (AREA x 2,000-FPM)	MAXIMUM ALLOWABLE CFM DAMPER LEAKAGE
6	393	6.0
8	698	11.0
10	1091	17.0
12	1571	20.0
14	2138	30.0

2. Flow Measurement: Airflow through the unit shall be accomplished by the use of a metal multi-port velocity pressure cross sensor or multi-axis flow ring devices with a minimum of four (4) radially distributed pick-up points connected to a center averaging chamber.

C. Access Plenum:

3. Single duct units with hot water coils shall be provided with one access section or plenum between the single duct terminal and the coil, and another access downstream of the coil, for coil inspection. Plenum construction shall be equal to the quality of materials and workmanship of the terminal unit.
4. Access plenum may also be used as a transition. Construct with a transition angle not to exceed 15-degrees.

5. Access plenum shall contain a minimum of a 12-in diameter or 12-in x 12-in (or full unit width if less than 12-in) access door as specified in Section 23 33 00.
6. Door frame may be bolted, screwed, or flanged and sealed to the casing. Door shall be gasketed and shall be double wall construction or insulated similar to main casing. Door shall be held in place with latches or other captive retainer devices.

D. Hot Water Heating Coil:

1. Heating coils shall be installed on terminal units without exception and regardless of area served. The heating coil shall be provided with modulating temperature controls. Reference *Section 23 82 16* for specifications on coils.
 - a. Note: At the Contractor's option, coils may be provided by the equipment manufacturer listed in separate sections. Coils provided by the equipment manufacturer shall meet the full requirements of this section.

E. Unit Controls:

1. General Performance: Flow stations, control transformers, disconnect switch, and controls enclosure shall be furnished, mounted and adjusted by the terminal unit manufacturer to assure their proper placement within the units. If DDC controls of another manufacturer (not the terminal unit manufacturer) are provided for the Project, the terminal unit manufacturer shall be responsible only for construction of the terminal unit and installation of internal control components installed at the manufacturer's factory and shall not be responsible for installation of controls not installed at the terminal unit manufacturer's factory, nor shall the manufacturer be responsible for the performance of the DDC controls. The performance of DDC controls in connection with terminal units shall be the responsibility of the BAS Provider.
2. Control Performance: Assemblies shall be able to be reset to airflow values between zero and the maximum CFM shown on Drawings. To allow for maximum future flexibility, it shall be necessary to make only simple screwdriver or keyboard adjustments to arrange each unit for specified maximum airflow within the ranges for each inlet size as scheduled on the Drawings. The control devices shall be designed to maintain the desired flow regardless of inlet flow deflection.
3. Control Sequences: Terminal units shall be shipped from the manufacturer with necessary control devices to accomplish each sequence, except as may be prohibited by the BAS Provider.

F. DDC Controls Protocol/Description:

1. BAS Provider shall be responsible for providing damper actuators, linkages, flow transducers, controllers, room temperature sensors, and other devices required for unit control, except as specified below.
2. BAS Provider shall be responsible for calibrating the actuator and its controller through TAB work for scheduled airflow rates. Units shall be capable of field calibration and readjustment with external gauge taps.
3. Unit manufacturer shall provide unit inlet flow sensor and pneumatic tubing for BAS Provider's use.

4. Unit manufacturer shall factory install devices furnished by BAS Provider to result in a complete functioning unit. Unit manufacturer shall be responsible for reviewing compatibility of devices furnished by BAS Provider to units provided.

2.4 SINGLE DUCT VARIABLE OR CONSTANT VOLUME TERMINAL UNIT

- A. Pressure independent, single duct variable or constant air volume control assemblies with integral attenuator, of the sizes, capacities and configurations as scheduled on the Drawings.
- B. Unit pressure drop across the assembly with an equivalent 2,000-fpm inlet velocity through the inlet shall not exceed 0.15-in water gauge.
- C. Air terminal units shall be selected with set air and water flow rates, set entering air and water temperatures. Discharge air shall be allowed to be between 90-deg-F and 110-deg-F. Return water temperature shall be at the system design return water temperature and allowed to be higher only if required to meet 0.5-gpm flow minimum. Variations from this require written approval of the Owner.
- D. Sound Ratings: Sound power levels shall be obtained from testing in accordance with AHRI Standard 880.
- E. Fan powered terminal units are prohibited.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall meet or exceed applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. Installation shall be in accordance with manufacturer's published recommendations.
- C. Provide clearance for inspection, repair, replacement, and service. Ensure accessibility to terminal unit electrical control panel doors, controllers and operators are located a minimum of 42-inches from all obstructions (walls, pipe, etc.).
- D. Wiring and controller compartments, electronic motors and damper motors shall have a minimum 42-inch clear wide and deep working space readily accessible from lift out ceiling tiles or access panels.
- E. Provide ceiling access doors or locate units above easily removable ceiling components.
- F. Install terminal units with a minimum of four (4) diameters of straight duct directly prior to the entry into each terminal unit connection.
- G. Support units individually from structure. Terminal units shall be supported using units hanger brackets and threaded rods. Do not support from adjacent ductwork. Refer to other Division 23 Section(s) for vibration isolation requirements.
- H. Connect to ductwork in accordance with Section 23 31 00.
- I. Install heating coils in accordance with Section 23 82 16.

END OF SECTION 233600

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 233700 – AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with ASHRAE 70.
- B. Test and rate performance of louvers in accordance with AMCA 500.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Submit product data and Shop Drawings, indicating type, size, location, application, noise level, finish, and type of mounting.

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.
- B. Grilles, registers and diffusers shall be as scheduled on the Drawings and shall be provided with sponge rubber or soft felt gaskets. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five (5) foot occupancy zone will not exceed 50 fpm nor be less than 25 fpm except where indicated otherwise. Noise levels shall not exceed those published in ASHRAE for the type of space being served (NC level). In the vicinity of lab hoods, terminal velocity at face of hood shall exceed 20 fpm.
- C. Perforated face diffusers shall be prohibited. Sidewall supply diffusers shall be of the double deflection design. Sidewall return or exhaust grilles shall be of the fixed blade design.
- D. All diffusers and registers shall be without volume control dampers. Volume control shall be via dampers provided in the ductwork at the take off from main or branch ducts.
- E. Locations of air distribution devices on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be influenced by the established general pattern of the lighting fixtures or architectural reflected ceiling plan, but primarily located to maintain proper air distribution. Where called for on Drawings, grilles, registers and diffusers shall be provided with deflecting devices and manual dampers. These grilles, registers, and diffusers shall be the standard product of the manufacturer, and subject to review by the AE.
- F. Provide a frame compatible with the type of ceiling or wall in which the devices are installed. Refer to Architectural Drawings for exact type of ceiling specified.
- G. Coordinate color and finish of the devices with the AE.

2.2 MANUFACTURERS

A. Grilles, Registers, and Diffusers:

1. Titus Products.
2. Price Industries.
3. Nailor Industries.

B. Louvers:

1. Ruskin.
2. Greenheck.
3. Arrow.

C. Roof Hoods:

1. Greenheck.
2. Cook.
3. Acme.

2.3 ROUND CEILING DIFFUSERS

- A. Round, adjustable pattern, stamped or spun, multicore type diffuser to discharge air in 360-degree pattern, with sector baffles where indicated.
- B. Project diffuser collar above ceiling face and connect to duct with duct ring. In plaster ceilings, provide plaster ring.
- C. Fabricate of aluminum, unless otherwise noted, with factory baked enamel, off-white finish.
- D. Provide multi-louvered equalizing grid where noted on the drawings or schedules.

2.4 RECTANGULAR CEILING DIFFUSERS

- A. Rectangular, full louvered face, directional, removable multi-core type diffuser to discharge air in 360-degree pattern. Neck size shall be as scheduled on the Drawings. Provide filler panels, where required, for directional throw diffusers.
- B. Fabricate frame and blades of extruded aluminum with factory baked enamel, off-white finish.
- C. Provide multi-louvered equalizing grid.
- D. Provide round neck connection as scheduled on Drawings.

2.5 SQUARE PANEL FACE SUPPLY AND RETURN AIR CEILING DIFFUSER

- A. Architectural diffuser with a square panel centered within a square housing similar to the Titus OMNI model. Drawings that depict two-way and three-way throw options are achieved with the use of filler panel (where required) for directional throw diffusers.

- B. Although the manufacturers show this model being used only as a supply air device, this same diffuser can also be used as a return air device. The neck connection shall be the largest available neck size provided by the manufacturer.
- C. Provide round neck connection as scheduled on Drawings.

2.6 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Streamlined blades, depth of which exceeds 3/4-inch spacing, with spring or other device to set blades, vertical face.
- B. Fabricate 1-inch margin frame with concealed mounting.
- C. Fabricate of steel with minimum 20 gage frames and minimum 22 gage blades, steel and aluminum with minimum 20 gage frame, or aluminum extrusions, with factory baked enamel finish.

2.7 CEILING LINEAR SLOT DIFFUSERS

- A. Continuous linear flow bar slot with adjustable vanes for left, right, or vertical discharge, with volume control. Provide slot width, length and number of slots as scheduled on the Drawings.
- B. Fabricate of aluminum extrusions with factory baked enamel finish.
- C. Provide support clips and gasket as required for ceiling system.
- D. Provide alignment strips for hairline joints and end caps where the slot terminates. Provide mitered corners.
- E. Provide black matte finish for all interior exposed-to-view components.
- F. Provide externally insulated supply air plenum by diffuser manufacturer.
- G. Provide return slot diffuser same as supply, except without the adjustable vane control. Provide return air plenum for ducted return where indicated on Drawings.

2.8 PLENUM SLOT SUPPLY AND RETURN DIFFUSERS

- A. Supply or return plenum slot, 3/4-inch single extruded aluminum curved deflector blade to create a tight horizontal airflow pattern across the ceiling. Provide slot width, length, and number of slots as scheduled on the Drawings.
- B. Diffusers shall discharge air horizontally through two outside sections and vertically through a center down-blow section.
- C. Standard nominal lengths shall be 2, 3, 4, or 5 feet. Units shall be constructed of 24 gage steel. Maximum height of the unit's plenum shall be 9-inches. Inlets shall have a minimum of 1-1/2-inch depth for duct connection. The standard finish shall be black on the face of the diffuser and pattern deflectors.
- D. Diffuser shall be similar to Titus N-1-R diffuser.

2.9 CEILING LINEAR EXHAUST AND RETURN GRILLES

- A. Streamlined blades with 90-degree one-way deflection, 1/8-inch x 3/4-inch on 1/4-inch centers.
- B. Fabricate 1-inch margin frame with countersunk screw mounting.

- C. Fabricate of steel with 22 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Where not individually connected to exhaust fans, provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.10 WALL SUPPLY REGISTERS/GRILLES

- A. Streamlined and individually adjustable curved blades to discharge air along face of grille with two-way deflection.
- B. Fabricate 1-inch margin frame with countersunk screw, concealed mounting and gasket.
- C. Fabricate of aluminum extrusions with factory clear anodized finish.
- D. Provide multi-louvered equalizing grid.

2.11 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Streamlined blades, depth of which exceeds ¾-inch spacing, with spring or other device to set blades, vertical or horizontal face as scheduled.
- B. Fabricate one-inch margin frame with concealed mounting.
- C. Fabricate of aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish.

2.12 LINEAR BAR WALL DIFFUSERS

- A. Streamlined blades with 0 to 15 degree deflection, as scheduled, 1/8-inch x 3/4-inch or 1/4-inch centers.
- B. Fabricate of aluminum extrusions, with factory clear anodized finish.
- C. Fabricate 1/2-inch margin frame with concealed mounting and gasket.
- D. Provide concealed fastening, straightening grids and alignment bars.
- E. Provide externally insulated plenums by diffuser manufacturer.
- F. Provide return bar diffusers same as supply with return air plenum.
- G. Silhouette finish.

2.13 LINEAR FLOOR SUPPLY REGISTERS/GRILLES

- A. Streamlined blades with zero degree deflection, 7/32-inch x 3/4-inch on 1/2-inch centers.
- B. Fabricate of high-grade aluminum extrusions with factory clear anodized finish.
- C. Fabricate 3/16-inch margin heavy margin frame with concealed mounting and gasket and mounting frame. Frameless flange for floor installation. Silhouette finish.
- D. Provide concealed fastening, straightening grids and alignment bars.

2.14 LABORATORY RADIAL AIR SUPPLY DIFFUSERS

- A. High-volume, low velocity performance.
- B. Diffuser shall provide non-aspirating radial air pattern and shall be configured with air supply plenums with inlet collars to assure uniform velocity over the diffuser face.
- C. Furnish stainless steel back pan and stainless steel faced diffusers for animal holding rooms.
- D. Furnish aluminum back pan and aluminum-faced diffusers for laboratories.
- E. Performance face drops below ceiling, single-pane back pan and single piece lower chamber. Sectioned diffuser is not acceptable.

2.15 LOUVERS AND SCREENS

- A. Relief, exhaust, or intake air openings shall be provided with storm-proof louvers. Louvers shall be of extruded aluminum construction.
- B. Louvers shall be 0.080 inch minimum blade and frame thickness. Blade angle shall be 45 degrees. Minimum depth of louver section shall be 4 inches.
- C. Insect screens are prohibited.
- D. Intake openings shall be sized for an actual velocity of not to exceed 500 FPM through the available net free area, including bird screen. This limit is imposed in order to reduce air noise and the tendency to pull snow and debris into the ductwork.
- E. Intake ductwork shall be pitched to drain towards the louver. Ductwork shall be water tight and attached to the top side of the bottom blade of louver to allow complete drainage to the outside.

2.16 LOUVERED PENTHOUSES AND GRAVITY INTAKES

- A. Throat velocities shall not exceed 600 FPM for Louvered Penthouses and 300 FPM for gravity intakes. Louvered Penthouses shall be a minimum of 0.080 inch aluminum construction with 1 ½" x 1 ½" x 1/8" aluminum frame. Gravity intakes shall be a minimum of 18 gauge aluminum construction. Both units shall have aluminum bird screen and have insulated tops. A welded stainless steel pan with capped drain shall be provided at bottom of ductwork risers or beneath bottom of duct opening. All units shall be installed on curbs that have a minimum height of 18 inches and that are securely mounted to roof deck.

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. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, reflected ceiling plans, symmetry, and lighting arrangement.
- D. Install air outlets and inlets to ductwork with airtight connection.

- E. Provide balancing dampers on duct take-off to diffusers, grilles and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- F. Provide all specialties and frames for air distribution devices as required for proper installation in ceiling type as indicated on Architectural Drawings. Provide all cutting and patching of T-bars, gypsum board, and other ceiling systems as required for installation of air devices.

END OF SECTION 233700

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 234000 - AIR CLEANING

PART I - GENERAL

1.1 WORK INCLUDES

1. Filters and Filter Media.
2. Filter Frames.
3. Filter Gauges.

1.2 QUALITY ASSURANCE

- A. Filter media shall be ANSI/UL 900 listed, Class 1 or Class 2, as approved by local authorities.
- B. Provide all filters and filter banks by one manufacturer.

1.3 SUBMITTALS

- A. Submit shop drawings per *Section 01 33 23 – Shop Drawings, Product Data, and Samples*. Include data on media, performance, assembly and frames.

1.4 EXTRA STOCK

- A. Coordinate and provide additional filter set(s) for compliance during allowed use of permanent equipment for and during construction.
- B. Provide clean filters in all units at time of installation if equipment will not be allowed to be used for/and during Construction and if flush out procedure is not utilized.
- C. Provide one additional set of replacement filters for all units beyond standard sets listed under internal components. Provide clean filters in all units at project final completion after all interior finishes are complete.

PART 2 - PRODUCTS

2.1 MEDIUM EFFICIENCY, DISPOSABLE, TYPE D

- A. Non-woven cotton fabric, pleated media, disposable type with welded wire grid support bonded to the filter media.
- B. Heavy duty, paper board frame with diagonal support members bonded to inlet and exit sides of each pleat. Bond frame to media periphery to eliminate air bypass.
- C. 4" thick media with at least 4.6 square feet of media per square foot of face area. Maximum initial resistance of 0.30" WG at 500 fpm face velocity.
- D. 25-30% efficiency and 90-92% arrestance per ASHRAE 52.1 or MERV 8 per ASHRAE 52.2.
- E. Acceptable Manufacturers: Farr, Continental or American Air Filter.

2.2 65% EFFICIENT ARRESTANCE (52.1) BAG FILTER, TYPE H

- A. Disposable type with high density, fine fiber glass media with reinforced backing and galvanized steel face frame.
- B. Self supporting bags without sag under airflow reduced to 25% of the maximum design flow.
- C. Individual pleats shall have sealed link stitching to maintain their shape.
- D. Minimum of 22". At least 17.5 square feet of media per square foot of face area.
- E. 60-65% efficiency and >98% arrestance per ASHRAE 52.1 or MERV 11 per ASHRAE 52.2. Maximum 0.22" WG initial resistance at 375 fpm face velocity.
- F. Acceptable Manufacturers: Farr, Continental or American Air Filter.

2.3 85% EFFICIENT ARRESTANCE (52.1) BAG FILTER, TYPE I

- A. Disposable type with high density, fine fiberglass media with reinforced backing and galvanized steel face frame.
- B. Self supporting bags without sag under airflow reduced to 25% of the maximum design flow.
- C. Individual pleats shall have sealed link stitching to maintain their shape.
- D. Depth of 22". At least 25.25 square feet of media per square foot of face area.
- E. 80-85% efficiency average 95% arrestance per ASHRAE 52.1 or MERV 13 per ASHRAE 52.2. Maximum 0.35" WG initial resistance at 375 fpm face velocity.
- F. Acceptable Manufacturers: Farr, Continental or American Air Filter.

2.4 95% EFFICIENT ARRESTANCE (52.1) BAG FILTER, TYPE J

- A. Disposable type with high density, fine fiberglass media with reinforced backing and galvanized steel face frame.
- B. Self supporting bags without sag under airflow reduced to 25% of the maximum design flow.
- C. Individual pleats shall have sealed link stitching to maintain their shape.
- D. Depth of 22". At least 17.5 square feet of media per square foot of face area.
- E. 90-95% efficiency average 99% arrestance per ASHRAE 52.1 or MERV 14 per ASHRAE 52.2. Maximum 0.55" WG initial resistance at 375 fpm face velocity.
- F. Acceptable Manufacturers: Farr, Continental or American Air Filter.

2.5 FILTER FRAMES

- A. Provide standard frames. Provide additional structural supports as required to maintain minimal deflection at worst case operating condition. Worst case condition is snow packed filters at maximum air flow.

2.6 HIGH EFFICIENCY FILTER TEST HOLE

- A. 1-1/2" gasketed instrument type test hole with heavy screw cap.
- B. Acceptable Manufacturers: Ventlok 699.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install all products per manufacturers' instructions.
- B. Seal filter media to prevent passage of unfiltered air around filters with rubber or neoprene gaskets.
- C. Install static pressure taps upstream and downstream of each bank of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and calibrate. Every filter bank, including packaged units, shall have a filter gauge.
- D. Install four (4) high efficiency filter test holes, two upstream and two downstream, at all high efficiency filter banks in air handling units and ductwork (85% efficiency and higher). Coordinate location of test holes with Owner.

END OF SECTION 234000

This section of the *UIS Facilities Standards* establishes minimum requirements only.

It should not be used as a complete specification.

SECTION 235719 – SHELL AND TUBE HEAT EXCHANGERS

PART 1 - GENERAL

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 MANUFACTURERS

- A. Armstrong.
- B. ITT Bell & Gossett.
- C. Taco.
- D. Approved Equal.

2.3 STEAM - LIQUID HEAT EXCHANGERS

- A. Provide shell and tube type heat exchangers with removable U-bend tube bundle, steam in shell, water in tubes, with capacity and passes scheduled on the Drawings.
- B. Construct in conformance with ASME code for unfired pressure vessels. Tube (water) side shall be rated for 150 psi minimum water pressure at 375 degrees F (design rating). Shell (steam) side shall be rated for 150 psi minimum water pressure at 375 degrees F (design rating). Certify by an authorized inspector holding a national board of boiler and pressure vessel inspector's commission.
- C. Shell:
 - 1. Steel with threaded or flanged pipe connections, steel mounting saddles.
 - 2. Steel tube sheets and tube supports.
- D. Heads: Cast iron or steel.
- E. Tubes: U-tube, ¾ inch minimum outside diameter, seamless copper with minimum wall thickness of .049", removable for inspection and cleaning.
- F. Trim:
 - 1. Provide vacuum breakers with heat exchangers.
- G. Sizing of the heat exchanger shall be based on a pressure of 2 psi at the steam connection.

2.4 LIQUID – LIQUID HEAT EXCHANGERS

- A. Provide shell and tube type heat exchanger with removable U-bend tube bundle, heated water in shell, primary water in tubes, with capacity and passes scheduled on the Drawings.

- B. Construct in conformance with ASME Code for Unfired Pressure Vessels. Tube (primary) side and shell (heated) side shall be rated for 150 psi minimum water pressure at 375 degrees F (design rating). Certify by an authorized inspector holding a National Board of Boiler and Pressure Vessel inspectors commission.
- C. Shell:
 - 1. Steel with threaded or flanged pipe connections, steel mounting saddles.
 - 2. Steel tube sheets and tube supports.
- D. Heads: Cast iron or steel.
- E. Tubes: U-tube type, $\frac{3}{4}$ inch minimum outside diameter, seamless copper with minimum wall thickness of .035", removable for inspection and cleaning.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with manufacturer's published recommendations.
- B. Install to permit removal of tube bundle with minimum disturbance to installed equipment and piping.
- C. Support heat exchangers on welded steel pipe and angle floor stand.
- D. Pitch shell to completely drain condensate.
- E. Pipe relief valves and drain valves to nearest floor drain.
- F. Provide a minimum of two (2) steam traps in parallel or as detailed on Drawings.

END OF SECTION 235719

This section of the *UIS Facilities Standards* establishes minimum requirements only. It should not be used as a complete specification.

SECTION 237313 - MODULAR AIR HANDLING UNITS

PART I - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes the following:
1. Modular (Semi-Custom) Air Handling Units (AHU)
 2. Modular Dedicated Outdoor Air Units (DOAU)

1.3 DEFINITIONS

- A. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
 3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.
- B. Abbreviations:
1. %: Percent.
 2. ACR: Assessment, Cleaning and Restoration.
 3. AHRI: Air-conditioning, Heating, and Refrigeration Institute Business.
 4. AHU: Air handling unit.
 5. AMCA: Air Moving and Conditioning Association.
 6. Amp: Ampere.
 7. ANSI: American National Standards Institute.
 8. ASHRAE: American Society of Heating, Refrigeration, and Air-Conditioning Engineers.
 9. ASTM: American Society for Testing and Materials.
 10. BHP: Brake horsepower.
 11. CFM: Cubic feet per minute.
 12. DOAU: Dedicated Outdoor Air Unit.

13. E.g.: Exempli gratia “for example.”
14. EMT: Electrical metallic tubing.
15. Etc.: Et cetera “and other similar things”
16. ETL: Edison Testing Laboratories.
17. EAT: Entering air temperature.
18. EWT: Entering water temperature.
19. F&S: Facilities and Services
20. FPI: Fins per inch.
21. FPM: Feet per minute.
22. FT or “: Feet
23. GFI: Ground-fault (current) interrupter.
24. HVAC: Heating, Ventilating, and Air-conditioning.
25. Hz: Hertz
26. ID: Inner diameter.
27. I.e.: Id est “in other words.”
28. IAQ: Indoor air quality.
29. In or “: Inches.
30. LAT: Leaving air temperature.
31. Lb.: Pound.
32. LWT: Leaving water temperature.
33. MSDS: Material safety data sheets.
34. MERV: Minimum Efficiency Reporting Value.
35. MPH: Miles per hour.
36. NADCA: National Air Duct Cleaners Association.
37. NEC: National electrical code.
38. NEMA: The National Electrical Manufacturers Association.
39. NFPA: National Fire Protection Association.
40. NPT: National pipe thread.
41. OA: Outside air.
42. OD: Outer diameter.
43. OSHA: Occupational Safety and Health Administration.
44. RPM: Revolutions per minute.
45. SMACNA: Sheet Metal and Air Conditioning Contractors National Association.
46. Sec.: Second.
47. SP: Static pressure.
48. SQ: Square.

- 49. TAB: Testing, adjusting, and balancing.
- 50. TSP: Total static pressure.
- 51. UIS: The University of Illinois at Springfield.
- 52. VFD: Variable frequency drive.
- 53. W.c.: Water column.

1.4 QUALITY ASSURANCE

- A. Unit shall bear ETL label.
- B. Installation, start-up and operation shall be in compliance with Manufacturer's recommendations and installation, operations, and maintenance manuals.

1.5 SUBMITTALS

- A. Dimensioned arrangement drawings of unit including plan, external elevations and internal sectional views and dimensions of overall unit, unit sections and significant components including:
 - 1. Large scale detailed cross sectional views of joint construction including panel-to-panel, floor-to-structure and panel-floor-frame connections.
- B. Component materials including insulation, metal gauge/thickness, finishes, coatings
- C. Approximate shipping weight
- D. Multi-section unit assembly details and instructions
- E. Assembled unit installation instructions
- F. Field piping and electrical power/control wiring instructions and diagrams
- G. Recommended / required service and operation clearances
- H. Damper size and performance data including air velocity and pressure drop
- I. Fan data including following:
 - 1. Fan type and class
 - 2. Wheel type, size
 - 3. Airflow (CFM), total static pressure (TSP), speed (RPM)
 - 4. Motor input frequency (Hz)
 - 5. Performance curves indicating specified operating point at design conditions
 - a. Individual fans
 - b. Fans in a group operating as unit
 - c. Initial design operating conditions
 - d. Future design operating conditions, as applicable
- J. Fan motor data
 - 1. Type, rated BHP, RPM, electrical characteristics
- K. Coil data
 - 1. Coil type, configuration, number of rows
 - 2. System fluid (water, % glycol)

3. Tube material, size (diameter), wall thickness
 4. Fin type, material, thickness, density (FPI)
 5. Coating data as applicable
 6. Header material, connection size
 7. Water flow rate, EWT, LWT, tube velocity, pressure drop
 8. Airflow rate, EAT, LAT, face velocity, pressure drop
 9. Certified thermal performance
- L. Filter data
1. Type, size, efficiency, velocity, clean/dirty pressure drop
- M. Energy recovery wheel data
1. Dimensioned drawings
 2. Structural component materials, finishes
 3. Media
 - a. Type, detailed description, manufacturing process
 - b. Number, dimensions of segments
 - c. Airflow rates, face velocities, pressure drops, both sides of wheel
 - d. Purge angle, purge air flow rate
 - e. Entering and leaving air conditions, both sides
 4. Belt, motor data
 5. VFD data
 6. Media segment installation / replacement instructions
- N. Plate Heat Exchanger Data
1. Dimensioned drawings
 2. Structural component materials, finishes
 3. Plate thickness, spacing
 4. Coating data, as applicable
 5. Airflow rates, face velocities, pressure drops, both sides of exchanger
 6. Entering and leaving air conditions, both sides
- O. Heat Pipe Data
1. Dimensioned drawings
 2. Structural component materials, finishes
 3. Tube, fin materials and thickness
 4. Coating data, as applicable
 5. Airflow rate, EAT, LAT, face velocity, pressure drop
 6. Certified thermal performance

- P. Static pressure (SP) drops at operating conditions for each component (e.g. coils, energy recovery devices). Pressure drop for clean filters and separate pressure drop for loaded “dirty” filters
- Q. Design external SP for system
- R. Unit sound power levels, (8) octave
 - 1. Discharge, inlet, radiated
- S. Catalog data, brochures and illustrations for unit including auxiliary devices (e.g. energy recovery wheel, humidifier, UV light)
- T. Manufacturer’s installation, operation and maintenance manuals for unit including auxiliary devices
- U. Complete structural drawings
 - 1. Curbs, supports, platforms, ladders, railings
- V. Test Reports
 - 1. Certified factory test reports as applicable
 - a. Fan balance
 - b. Air leakage test
 - 2. Field test reports as applicable
 - a. Fan balance
 - b. Air leakage
- W. Startup report
- X. Test and balance report
- Y. Signed and dated warranty documents
 - 1. Air handling unit
 - 2. Energy recovery wheel(s)

1.6 DELIVERY, STORAGE, PROTECTION

- A. AHU and associated equipment shall be delivered to job site suitably packaged and protected for overland trucking using heavy-duty protective shrink-wrap plastic.
 - 1. Items shipped loose such as filters, steam humidifier assemblies, etc. shall be suitably secured in unit or on separate pallet similarly protected.
- B. Unit shall be stored in clean, dry environment protected from exposure to dust, debris and fluids.
 - 1. Temporary covers shall be maintained over openings in unit housing throughout storage and system installation to greatest degree possible.
- C. Construction Phase Operation
 - 1. AHU shall not be operated during construction phase of project unless specifically indicated otherwise in project documents.
 - 2. Unit shall not be operated in any manner that exposes it to inadequately filtered air flow. If unit is operated in dirty airflow conditions filters shall be changed frequently. Additional filtration shall be provided if practical.

1.7 EXTRA STOCK

- A. In addition to filters provided with AHU, spare set of filters shall be provided.
- B. For each belt driven fan, replacement set of matched belts shall be provided once proper belt length has been determined by TAB Contractor.

1.8 WARRANTY

- A. Air handling unit including energy recovery wheel and other auxiliary devices shall be warranted by Manufacturer to be free from defects in material and workmanship and perform as specified for period of one year from date of startup or 18-months from date of delivery whichever occurs first. In satisfying requirement of warranty Manufacturer shall repair or replace unit at no cost to Owner.
 1. Repaired unit shall be like new with no cutting, patching or notable modification as determined by AE or Owner.
- B. Energy Recovery Wheel – Unconditional Ten Year Parts and Labor Warranty
 1. Energy recovery wheel assembly in entirety including motor, belt(s), gear drive and electrical components shall be warranted by heat recovery wheel Manufacturer to be free from defects in material and workmanship and to perform as specified for period of ten years from date of startup.
 2. Further, for same time period, warranty shall cover cost of parts and labor to repair, replace and/or adjust components as required for proper operation and full functionality.
 3. Warranty shall include conformance to specified maximum allowable wheel deflection of 1/32" at design airflow and pressure differential conditions throughout full term of warranty. Reference section below entitled ENERGY RECOVERY WHEELS.
 4. Warranty shall apply unconditionally to required repair, replacement or adjustments resulting from normal wear as well as manufacturing-related causes. Normal wear shall include but not be limited to replacement of motors, belts and drive components.
 5. If necessary to accomplish above stated warranty, Manufacturer shall replace entire wheel at no cost to Owner.
 6. Repaired or replaced unit shall be like new with no cutting, caulking, patching or notable modification as determined by AE or Owner
 7. Unconditional ten year warranty specified herein shall take precedence over Manufacturer's published warranty.
 8. Full satisfaction of this warranty as detailed above shall be at no cost to Owner.

1.9 MANUFACTURER SERVICES

- A. AHU Manufacturer authorized service technician shall provide:
 1. Periodic observation and oversight during field assembly/installation of AHU as required to ensure proper installation
 2. Preoperational inspection, oversight of startup and operator instruction including installation, operations, and maintenance manuals. Submission of startup report and dated warranty document to Owner
 3. Oversight and witness of field tests specified herein. Submission of test reports to AE and Owner

- B. Energy recovery wheel Manufacturer's authorized service technician shall provide:
 - 1. Preoperational inspection, oversight of startup and operator instruction including installation, operations, and maintenance manuals. Submission of startup report and dated warranty document to Owner
 - 2. Oversight and witness of field tests specified herein. Submission of test reports to AE and Owner
 - 3. Services required to satisfy ten year unconditional warranty

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS – INDOOR AIR HANDLING UNIT (STANDARD UNIT)

A. MANUFACTURERS

- 1. Air Handling Units and Dedicated Outdoor Air Units
 - a. Basis of Design: Air Flow Equipment Company / E Series
 - b. Or comparable product by the following:
 - 1) York Solution Series
 - 2) Daikin Vision Series
- 2. Energy Recovery Wheels
 - a. Standard applications, including laboratory general exhaust
 - 1) Thermotech
 - 2) Seibu Giken / SG America
 - 3) SEMCO

B. Basic Construction

- 1. AHU shall consist of sectionalized casing panels and flooring mounted upon a structural base. Unit shall incorporate fans, coils, filters, dampers and other components as indicated within project documents.
- 2. AHU, including structural base, flooring and casing panels, shall have adequate rigidity to satisfy specified deflection limits under operating conditions.
- 3. Unit shall be completely water tight and shall be air tight within specified leakage test limits in operating conditions.
- 4. Joints shall be sealed via inherent self-sealing design, butyl tape, or non-permeable gasket.
- 5. Unit shall have true thermal break construction.

C. Dimensions

- 1. Air handling unit selections specified herein and as indicated on the drawings are basis of design. Dimensions and other physical characteristics may slightly vary depending on manufacturer submitted. Such shall be fully coordinated with building/equipment room layout and available space.
- 2. Contractor and manufacturer shall verify that layout and dimensions of installed unit allow adequate clearances for equipment access, pull space, door swings, etc. Such shall include coordination with other equipment and systems including ductwork, piping, electrical, etc.

D. Thermal Performance

1. Exterior panels and floor of conditioned sections shall have minimum R value of 13 for 2" thick panels.
2. Exterior surfaces and floor of conditioned sections shall not condense or frost given design operating temperature and humidity conditions, internal and external to unit.

E. Deflection

1. Deflection of components including wall, floor and roof panels shall not exceed 1/240-th of span under full operating conditions unless specified otherwise.

F. Configuration

1. AHU shall be configured as specified herein and as indicated on drawings.

G. Additional Configuration Requirements

1. Mixed air units shall be configured to optimize mixing of return air and outdoor air over full range of velocities.
2. To degree possible, outdoor air path shall be located above and centered upon return air path to minimize stratification. To degree possible, air streams shall enter mixing chamber from front, top or bottom rather than from either side. Coordination with Installing Contractor shall be provided.
3. Mixing chamber shall be of adequate length to ensure good mixing prior to filters. Dampers, including minimum OA damper shall be positioned and oriented to optimize mixing.
4. Air blending device(s) and associated bypass dampers shall be provided to ensure thorough mixing of outdoor air and return air.
5. Velocity profile of air entering filter bank shall be such that maximum allowable airflow velocity is not exceeded at any point on downstream coil.
6. 100% outdoor air units (located indoors or outdoors) shall be configured to minimize ingress of snow and associated snow loading of filters.
7. AHU Manufacturer shall contact AE prior to bid to review any configuration deemed vulnerable to inadequate mixing or snow ingress. Recommended design changes shall be provided by Manufacturer to AE.

H. Access

1. Access section with man door shall be provided between each major component section. Access door opening shall be nominal 24" wide x 60" high. Height may be reduced only to degree limited by AHU dimension. In no case shall space between coils be less than 24".
2. Interior components shall be fully accessible including rotating equipment (e.g. fans, energy recovery wheels) and auxiliary equipment (humidifiers, UV lights).
3. Internal components including fans, motors and energy recovery wheels shall be removable without significant unit disassembly. Access doors and removable panels shall be provided as required to provide such access without impacting structural integrity of unit.

I. Coatings

1. Non-galvanized steel components shall be primed and painted prior to assembly.

2.2 BASE

A. Base Rail Requirements

1. Structural base rail shall be provided under full perimeter of unit with cross supports provided as required for rigid assembly.
2. Base shall have factory fabricated lifting lugs.

2.4 FLOOR

A. General

1. Floor shall be completely insulated beneath with rigid two-part expanded urethane foam. Thickness of insulation shall be as required to satisfy specified thermal resistance, 2" minimum. Foam insulation may be injected or spray applied and shall completely fill contours on underside of floor.
2. Sub-floor cover sheet shall be provided and shall completely encapsulate insulation. Sub-floor shall be G90 galvanized steel sheet.

B. Drain Pans

1. Pitched drainable stainless steel drain pans shall be provided in cooling coil, humidifier and heat recovery sections (located in outdoor air and exhaust air streams) in addition to other section(s) indicated.
2. Drain pans shall be double wall construction and shall be completely insulated with rigid two-part expanded urethane foam, 2" minimum thickness. Foam insulation may be injected or spray applied.
3. At no point shall fasters penetrate pan(s).
4. Drain pans shall be of sufficient depth and capacity to receive and drain by gravity "worst-case" water flow rate into pan.
5. Drain pans shall be double or triple sloped, pitched 1/8" per foot minimum toward outlet. Drain pans shall be IAQ compliant type and shall satisfy applicable requirements of ASHRAE Standard 62.1.
6. Drain pans and supports shall be constructed of type 304 stainless steel sheet.
7. Drain pans shall extend full width and length of AHU section and shall be configured / positioned to capture fluid / condensate. Cooling coil drain pans shall extend 12" minimum downstream of leaving coil face.
8. Drain pans shall incorporate one or more 1.5" NPT pipe connection(s) of same material welded to lowest point. Connection shall be extended through unit frame to provide complete drainage.
9. Drain outlets shall be of adequate elevation for installation of drain trap of sufficient depth to ensure full drainage of pan during "worst- case" AHU operation.
10. Intermediate Drain Pans
 - a. Intermediate drain pans shall be provided between coils when two or more cooling coils are stacked in assembly.
 - b. Intermediate drain pans shall satisfy requirements of primary drain pan.
 - c. Intermediate pans shall begin at leading face of coil and be of sufficient length extending downstream to prevent dripping or sheeting condensate from passing through air stream of coil below.

- d. Intermediate pans shall include drain tube to direct condensate to primary drain pan. Drain tube shall be constructed of copper, aluminum or stainless steel.
- e. Intermediate pan outlets shall be located at lowest point of pan and shall be sufficient diameter to preclude drain pan overflow under any operating condition.

2.5 CASING PANELS

A. Exterior Panels

1. Formed and reinforced panels shall be double wall, 2 inches minimum thickness.
2. Outer casing and inner liner shall be G90 galvanized steel sheet for standard applications.
4. Inner liner shall be solid sheet. Perforated metal liner not allowed. Additional attenuation, if required, shall be provided via dedicated attenuator located within unit or within duct.
5. Panels shall form water tight and airtight seal with adjacent panels. Fasteners shall not penetrate into air tunnel.
6. Panels shall be completely insulated with rigid two-part expanded urethane foam. Foam insulation shall be injected into cavity between outer casing and inner liner. Cavity shall be completely filled with no voids. Rigid board, semi-rigid board or spray applied insulation not acceptable.

B. Interior Panels (Partition Walls)

1. Formed and reinforced panels shall be double wall construction with thickness and insulation same as specified for exterior panels.
2. Internal panels shall be completely sealed at connections to adjoining surfaces with non-permeable gaskets.

C. Interior Blank-Offs and Safing

1. Blank-offs and safing shall be G90 galvanized steel sheet for standard applications. Such shall be type 304 stainless steel for corrosive exhaust applications.

D. Wall Penetrations

1. Wall penetrations shall be kept to minimum and to greatest extent possible shall be located on same side of unit housing as doors.
2. Pipe, tubing and electrical conduit shall be extended through wall of unit and properly terminated at unit exterior. Electric conduit and wiring shall be terminated in junction box or other approved enclosure mounted on unit exterior.
3. Wall penetrations shall be tightly sealed around components passing through wall.
4. Grommet shall be provided to provide tight seal around coil piping passing through panel opening.

E. Duct Connections

1. Flanged openings shall be provided for duct connections.

2.6 DOORS

- A. Access doors shall be provided as specified herein and as indicated on the drawings, and shall satisfy following requirements:
 1. Doors shall be hinged double wall construction.

2. Wall thickness, materials of construction and metal gauge shall be equal to that of corresponding wall panels, minimum.
3. Doors shall be insulated with same material as surrounding walls and shall comply with same thermal resistance performance requirements.
4. Doors shall incorporate continuous non-permeable gasket.
5. Each door shall have minimum of two (2) high compression latches, operable from both sides. Doors on outdoor units shall have securable padlock hardware.
6. Door dimensions shall be nominal 24" wide x 60" high minimum unless indicated otherwise. In no case shall door be less than 18" wide. Door(s) at fan section(s) shall be sufficiently sized to allow motor replacement.
7. Each door servicing positive pressure section of AHU shall open inward. Each door servicing negative pressure section shall open outwards.

2.7 INTERNAL COMPONENTS

A. Air Blending Devices

1. If indicated, air blending / destratifying device(s) shall be provided to ensure thorough mixing of outdoor air and return air.
2. Air blending device(s) shall be sized and positioned within unit to optimize mixing for winter economizer operation; i.e. blender shall be sized for minimum expected airflow.
3. If winter airflow is less than maximum summer airflow, bypass damper shall be provided, located in parallel with blender to avoid excessive pressure drop and to facilitate air side economizer operation. Dampers shall be as indicated.

B. Fans and Motors

1. Fans shall fully comply with requirements of *Section 23 34 00 – HVAC Fans*. Referenced section presents more complete and detailed specifications for fans. As such, it shall be incorporated in its entirety into this document, Section 23 73 13 – Modular Air Handling Units by means of this reference.
2. Reference *Section 26 29 23 - Variable Frequency Motor Controllers* for VFD requirements.
3. Fans shall be housed centrifugal or plenum type, factory mounted complete with motor and drive.
4. Fans shall be selected for optimal efficiency at design operating point.
6. Number of fans shall be as indicated in the contract documents.
7. Plenum fans may be configured in "fan array" unless indicated otherwise.
8. Base support frame shall be provided for each fan.
9. Direct drive fans shall be selected such that at design conditions motor frequency shall be within 50-80-Hz range if possible. In no case shall motor frequency under any condition exceed 90-Hz.
10. Fan motors shall be 1,800-RPM synchronous speed unless indicated otherwise.
11. Motors for belt driven applications shall be provided with heavy duty slide bases.
12. For units with multiple parallel fans, each fan shall be provided with individual isolation damper to prevent reverse flow.
 - a. Damper shall be constructed of aluminum and shall be specifically designed and configured to yield negligible impact on fan performance.

13. Flexible duct connector shall be provided between discharge of each housed centrifugal fan and associated duct opening in AHU cabinet such that flexible duct connection is not required at unit exterior.
 14. OSHA approved guards shall be provided for fans, belts and sheaves as required for protection of service personnel. Guards shall be easily removable. Guards shall be designed to yield negligible impact on system performance.
- C. Vibration Isolators
1. Fan vibration isolators shall be provided and installed by AHU manufacturer.
 2. Fan(s) shall be sufficiently isolated such that isolation of AHU assembly is not required.
- D. Field Balance
1. Field balance not required unless, if in judgment of AE or Owner, vibration level is deemed questionable or unacceptable. In such case, vibration analysis and balancing shall be performed by qualified technician as specified above in *Section 23 34 00 - HVAC Fans*.
 - a. Referenced section indicates maximum allowable fan vibration level as follows:
 - 1) Belt-driven fans: 0.15-in/sec peak velocity, filter installed
 - 2) Direct drive fans: 0.10-in/sec peak velocity, filter installed
- E. Coils
1. Air coils, including heat pipe coils, shall fully comply with requirements of *Section 23 82 16 – Air Coils*. Referenced section presents more complete and detailed specifications for coils. As such, it shall be incorporated in its entirety into this document.
 2. Coils shall be positioned within air handling unit as specified herein and as indicated on the drawings.
 3. Provision shall be made for coils of adequate size to satisfy specified face velocity and pressure drop limitations. Specified face velocity limitations shall not be exceeded.
 4. For hydronic (water) coils, individual coil sections (i.e. sections with continuous plate fins) shall not exceed 48" in height.
 5. Length of coil sections shall not exceed limitations of available coil pull space provided adjacent to unit.
 6. Coils shall be completely enclosed within unit casing including return bends and headers.
 7. Fasteners and hardware shall be same material as connected components. Where connected components are dissimilar material, stainless steel fasteners shall be used.
 9. Heat pipe coils shall be configured and installed to ensure proper separation of supply and exhaust airstreams to prevent cross contamination.
 10. Coil piping, drain and vent connections shall be extended full size to unit exterior, same side as access doors unless otherwise indicated.
 11. Coil headers and piping within unit shall be factory insulated as required to prevent undesirable heat transfer or condensation. Reference *Section 23 07 19 – HVAC Piping Insulation* for insulation requirements. Protective lagging shall be provided by unit manufacturer on insulated piping within housing.
 12. Coils shall be installed dead-level in unit to ensure complete drainage by gravity.
 13. Moisture eliminators, if indicated, shall be chevron type.

F. Filters

10. Filters shall fully comply with requirements of Section 23 40 00 – HVAC Air Cleaning Devices.
11. Filters shall be front loading unless indicated otherwise.
12. To greatest extent possible filters shall be 24" x 24" nominal size. Otherwise filters shall be 24" x 12".
13. Prefilters shall be 4" pleated type, MERV-8. Final filters shall be 22" bag type, MERV-11 for standard applications and MERV-14 for laboratory applications.
14. Prefilters and final filters shall be positioned within AHU to provide filtering of air passing through coils, fans and auxiliary devices.
15. Final filters not required for units with design airflow rate no greater than 3,000-CFM.
16. If airflow entering heat recovery wheels, heat pipe coils, plate heat exchanger or run-around heat recovery coils is otherwise unfiltered, filter shall be provided upstream of such devices. Filters shall be 4" pleated type, MERV-8.
17. Filter frames shall be designed to hold specified prefilters and final filters in single frame. Filter frame assemblies shall be provided by Manufacturer and shall be factory installed.
18. Filter frames shall be assembled into racks. Structural supports shall be provided as required for rigidity. With filters snow-packed and unit operating at full design conditions filter support system shall remain un-deflected.
19. Filter frames shall be standard universal clip type constructed of 16-gauge galvanized steel or .08" (12 gauge) aluminum for standard applications.
20. Filter frames shall incorporate sealing flange with replaceable gasket.
21. Final filters located within AHU downstream of other internal components shall be provided only as required for special application.

G. Control Dampers

1. Control dampers shall be provided and placed as specified herein and as indicated on drawings.
2. Control dampers shall fully comply with requirements of *Section 23 09 13.43 - Control Dampers*. Referenced section presents more complete and detailed specifications for dampers. As such, it shall be incorporated in its entirety into this document, by means of this reference.
3. Referenced damper specifications shall also apply to:
 - a. Cooling coil bypass dampers
 - b. Energy recovery wheel bypass dampers
 - c. Heat pipe face-and-bypass dampers
 - d. Plate heat exchanger face-and-bypass dampers
 - e. Air blender bypass dampers
4. Special consideration shall be given to following:
 - a. Damper placement/configuration for optimized airflow mixing
 - b. Damper type (opposed vs. parallel blade) for optimized control.
 - c. Adequate pressure rating for AHU test pressure
 - d. Proper sizing for adequate damper authority

- e. Ease of damper removal/replacement
 - f. Access to damper linkage
 - g. Provision for proper actuator mounting
5. Selection and sizing of control dampers shall be governed by *Section 23 09 13.43 – Control Dampers*.
 6. Control dampers internal to unit shall be furnished and installed by AHU manufacturer. Damper actuation/automation shall be provided by Temperature Control Contractor.
 7. Mixing dampers shall be configured to maximize mixing of outdoor air and return air.
 8. For a mixed air unit, a dedicated “minimum outdoor air” damper shall be provided for modulating control of ventilation airflow at reduced overall system airflow rate. Minimum outdoor air dampers shall typically be opposed blade type.
 9. In cooling mode, external bypass damper shall allow no air leakage resulting in bypass of unconditioned warm/humid around cooling coil.
 10. Automated bypass damper shall be provided at air blending device to increase velocity when mixing of airstreams is required (closed position) and to decrease pressure drop when mixing is not required (open position).
 11. Without exception, automated bypass damper shall be provided at each energy recovery wheel on supply and exhaust side of wheel to enable bypass of air when wheel is not active to reduce air pressure drop, facilitate economizer operation and provide frost control. Dampers shall be sized such that combined airflow through damper and wheel is sufficient for 100% outdoor air economizer.
 12. Automated face-and-bypass dampers shall be provided at heat pipe and plate heat exchangers to enable bypass of air when device is not active to reduce air pressure drop, facilitate economizer operation and provide frost control. Dampers shall be sized such that combined airflow through damper and heat exchange device is sufficient for 100% outdoor air economizer.
 13. As stated above in section *Fans and Motors* fan isolation dampers shall be provided for multiple parallel fans to prevent reverse flow through an idle fan.
 14. Damper design and installation shall be coordinated with Temperature Control Contractor.
- H. Electrical
1. Electrical components and installation thereof shall comply with *National Electric Code (NEC)*.
 2. Electrical components and assemblies shall comply with *NEMA* standards.
 3. Electrical components and assemblies shall comply with requirements of *UIS Facilities Standards – Division 26 – Electrical*
 4. Conduit and Conductors
 - a. Electrical conduit and conductors for power, lighting, and other devices shall be provided by AHU manufacturer, factory and/or field installed. Field installation of conduit and conductors at module splits shall be provided by Installing Contractor.
 - 1) Exception: Conduit, conductors and enclosures shall not be provided for motors served by VFDs. In such cases conduit, conductors and enclosures shall be furnished and field installed by Electrical Contractor.
 - b. Separate circuits shall be provided for electrical power, lighting and controls/instrumentation.

- c. Conductors shall be enclosed within electrical conduit.
 - d. Conduit and conductors shall be terminated at one or more junction boxes or approved enclosures on unit exterior.
 - e. Size and location of conduits and electrical enclosures shall be coordinated with Electrical Contractor. Excess length of conductors shall be provided at each enclosure, coiled and tie wrapped.
 - f. Conduit shall be EMT, 3/4" minimum. Non-metallic conduit not allowed.
 - g. Use of flexible conduit shall be limited to that required by NEC. Flexible conduit shall not exceed 3' in length and shall be as short as possible at AHU shipping splits.
 - h. Use of flexible conduit in lieu of EMT not allowed.
 - i. Exposed conduit shall be securely clamped and supported with metallic pipe supporting devices rigidly fastened to structure.
 - j. Conduit shall be supported not more than 12" from points of connection to boxes and fittings. Conduit bends shall be supported not more than 12" from each change in direction.
 - k. Conduit shall be sealed in accordance with *NEC* to prevent moisture migration resulting in condensation within electrical components.
 - l. 20-Amp duplex electrical outlet shall be provided, mounted on unit exterior.
5. Auxiliary Equipment
- a. Factory installed conduit and wiring shall be provided for auxiliary equipment and shall be terminated in junction box or approved enclosure on AHU exterior.
 - 1) Exception: Conductors shall not be provided for VFD driven motors.

I. Controls

- 1. Control dampers and actuators shall be furnished and factory installed by AHU manufacturer in compliance with referenced specifications.
- 2. Filter differential pressure gauge(s) shall be furnished and installed by AHU manufacturer in compliance with specification provided herein.
- 3. Ultraviolet light controls shall be provided by AHU manufacturer.
- 4. With exception of items listed above, controllers and associated devices for monitoring and control including sensors, tubing, conduit, conductors and enclosures shall be furnished and field installed by others. Programming shall be provided by others.

J. Hydronic Piping and Valves

- 1. Hydronic piping and valves exterior to AHU shall be provided by AHU manufacturer only if specifically indicated within project documents. Reference related specifications for piping and valve requirements as applicable.

K. Humidifiers

- 1. Humidifier shall be provided if indicated within project documents. Humidifier shall be steam-to-steam reboiler type consisting of steam generation unit, steam dispersion manifold and associated components.
- 2. Entire humidifier assembly including steam generation unit, dispersion manifold, associated components and controls shall be furnished by Heating Contractor unless indicated otherwise within project documents. Heating Contractor shall furnish dispersion manifold, mounting brackets and hardware to AHU manufacturer for factory installation within AHU.

3. Humidifier manifold shall be securely positioned within dedicated AHU section located between heating coil and following downstream component (typically cooling coil) unless indicated otherwise.
4. Steam piping and manifold shall be insulated to provide burn protecting and minimize heat transfer to airstream. Insulation shall be provided by Installing Contractor.
5. Access section with man door shall be provided on downstream side of humidifier manifold unless indicated otherwise on drawings. In no case shall manifold be positioned less than 6" from upstream component or 18" from downstream component.
6. Steam shall be fully dispersed no less than 12" upstream of following component (typically cooling coil) under any operating condition. Undispersed water shall not impinge or condense upon said component.
7. Steam supply and condensate drain piping shall be extended through AHU housing and terminated outside unit.
8. Manufacturers
 - a. Dri-Steem
 - b. Armstrong
 - c. Sarco
 - d. Nortek

L. Instrumentation

1. Differential pressure gauge
 - a. Differential pressure gauge shall be provided at each filter bank, viewable on exterior of unit.
 - 1) Die cast aluminum case and bezel with acrylic cover
 - 2) 4" diameter face
 - 3) \pm 2% full scale accuracy
 - 4) 0-2.0" w.c. range
 - 5) Adjustable set point indicator
 - 6) Static pressure probes
 - 7) Mounting bracket
 - 8) Basis of design:
 - (a) Dwyer Magnehelic Series 2000
 - b. Gauge shall be exterior bracket mounted for ease of removal and access to tubing connections.
 - c. Separate differential pressure transmitter shall be provided by Temperature Control Contractor for remote monitoring.

2.8 ENERGY RECOVERY WHEEL(S)

A. Performance

1. Manufacturer shall provide certified performance data in accordance with ASHRAE-Standard-84 and AHRI-1060. Independent performance test results shall be used to rate product in accordance with AHRI Air-to-Air Energy Recovery Ventilation Equipment Program.

B. General Requirements

1. Casing

- a. Rotor casing shall be provided with structural framework to rigidly support rotor.
- b. Casing sheet metal shall be reinforced as required to provide solid mounting surface for peripheral and radial seals.

2. Rotor

- a. Rotor shall not deflect in excess of 1/32" from no-flow condition to full design airflow condition. Deflection shall be measured at rim of wheel where exposed to greatest force of airflow. Deflection shall be measured relative to wheel support frame.
- b. Rotor design shall allow replacement of media segments in field conditions without removal of rotor.
- c. Anti-rotation feature shall be provided to prevent reverse rotation.
- d. Energy recovery wheels that require field assembly shall be assembled by service personnel employed by manufacturer of heat transfer media such that warranty is maintained.

3. Rotor Bearings

- a. Rotor shall be supported by two pillow block bearings that can be maintained and replaced without disassembly of rotor.
- b. Bearings shall provide L10 life of 1,000,000 hours operation.

4. Rotor Seals

- a. Face seal and perimeter seal shall be provided to prevent cross leakage between two air streams.

5. Seals shall be field adjustable non-contact labyrinth type. Purge Sector

- a. Factory fabricated field adjustable purge unit shall be provided.
- b. Purge shall be designed to limit cross contamination to less than 0.5% of exhaust stream concentration at any operating condition for standard applications. Cross contamination shall be limited to 0.04% for laboratory fume hood applications or other systems conveying toxic or noxious vapors.

6. Drive

- a. Rotor shall be driven by belt system and electric motor.
- b. Motor shall comply with *Section 26 29 00 - Common Motor Requirements*.

7. Coating

- a. For non-laboratory applications, metal surfaces shall be galvanized or provided with corrosion resistant coating.
- b. For laboratory applications, metal surfaces exposed to airflow shall receive acid resistant epoxy or phenolic coating.

8. Filters

- a. Filtration shall be provided upstream of energy recovery wheel in each air path. As indicated within filter specification above, filters shall be front loading 4" pleated type, MERV-8.

- b. Filter assembly shall comply with requirements presented above in paragraph entitled *Filters*.
9. Controls
- a. Control devices and programming shall be provided by Temperature Control Contractor in accordance with requirements of *Section 23 09 23 – Building Automation System (BAS) for HVAC* and *Section 23 09 13 – Instrumentation and Control Devices for HVAC*.
 - b. Manufacturer / Installing Contractor shall coordinate installation of controls and startup of AHU with Temperature Control Contractor.
- C. Media
1. Total Enthalpy Wheel
- a. Wheel shall provide both sensible and latent heat recovery. Sensible and latent heat transfer effectiveness shall meet or exceed specified values.
 - b. Energy recovery effectiveness values shall be tested in accordance with ASHRAE-84 and shall be certified in accordance with AHRI-Standard-1060.
 - c. Media shall consist of corrugated aluminum foil substrate coated with molecular sieve desiccant or ion exchange resin configured into honeycomb structure. Edges shall have anti-corrosion coating.
 - d. Corrugations shall have high surface area per volume to ensure no fouling occurs on internal heat transfer surface. Dry particles up to 800-microns shall freely pass through media.
 - e. Molecular sieve and ion exchange resin coating shall be designed to selectively transfer water vapor while allowing other gaseous chemicals to pass.
 - 1) For standard applications, including laboratory general exhaust:
 - (a) Molecular sieve desiccant internal pore diameter shall limit absorption to materials having 4 angstrom kinetic diameter or less.
 - (b) Ion resin shall provide same or better performance in each and every regard.
 - f. Media shall be cleanable with low temperature steam, hot water or light detergent solution without degrading latent recovery.
 - g. Media shall have flame spread of less than 25 and a smoke developed of less than 50 when rated in accordance with ASTM-E-87.

2.9 PLATE HEAT EXCHANGERS

A. Description

- 1. Plate heat exchanger shall be stand-alone assembly of parallel heat transfer plates affixed within rigid supporting framework configured for installation within air handling unit.

B. Performance

- 1. Plate type air-to-air heat exchanger shall be AHRI Certified to *Standard-1060 – Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment* and shall bear the AHRI Certified Product Seal.

C. Materials of Construction

- 1. Clean air applications, including laboratory general exhaust:
 - a. Aluminum

D. Condensate Management

1. Heat exchanger shall be designed and oriented to facilitate condensate drainage to drain pan below without restricting airflow.
2. Heat exchanger shall be sized/selected to achieve design performance without condensate carryover into air stream. Face velocity shall typically not exceed that of associated cooling coil within AHU.

E. Leakage

1. Clean air applications including
 - a. Leakage rate shall not exceed 0.1% of airflow at 1.5" w.c. differential pressure

F. Dampers

1. Automated face and bypass dampers shall be provided to enable bypass of air when heat exchanger is not active to reduce air pressure drop, facilitate economizer operation and provide frost control.
2. Dampers shall be sized such that combined airflow through bypass damper and heat exchanger is sufficient to provide 100% outdoor air economizer.
3. For laboratory fume hood or other corrosive vapor applications, dampers shall be constructed of type 304 or type 316 stainless steel and/or coated with appropriate phenolic material (e.g. Heresite).
4. Dampers shall comply with requirements presented above in paragraph entitled Control Dampers and Actuators.
5. Dampers shall conform to requirements of Section 23 09 23 – Control Dampers.

G. Basis of Design:

1. Innergy Tech

2.10 HEAT PIPE COIL(S)

A. General

1. Linear-Tube Heat Pipe Coils
 - a. Shall provide passive heat energy exchange between two counter-flow air streams.
 - b. Shall be configured with tubes horizontal or vertical as indicated on drawings or otherwise indicated in project documents.
 - c. Shall be affixed and shall have no requirement for tilting to ensure specified performance in operating conditions.
 - d. Shall be single unit for heat exchange between adjacent airstreams
 - e. Shall be matched coil set with interconnecting piping for heat exchange between remote airstreams.
2. U-framed "wrap-around" heat pipe coils
 - a. Shall provide dehumidification of air at cooling coil location.
 - b. Shall incorporate adequate access between heat pipe and cooling coil on each side of cooling coil.
 - 1) Face-to-face clear dimension on each side of coil shall typically be 30" minimum but in no case shall be less than 24".

B. Configuration**1. Series Flow**

- a. Heat pipe tubes shall be configured in series circuits such that liquid and vapor travel in same direction around circuit making wicking and capillary action unnecessary.
- b. Basis of Design:
 - 1) Heat Pipe Technologies

2. Bidirectional Flow (Conventional)

- a. Individual heat pipe tubes shall incorporate interior tube wall enhancements for wicking of heat transfer fluid via capillary action for transfer of liquid and gas in opposite directions.
- b. Basis of Design:
 - 1) Innergy tech, Inc.
- c. Or comparable product by the following:
 - 1) Thermofin

C. Finned Tubes

1. Tubes shall be individually processed, charged, hermetically sealed and factory tested for leakage.

2. Series Flow

- a. Tubes shall be rigid copper tubing expanded into aluminum plate-type fins to form permanent bond.
- b. Tube diameter shall be 1/2" or 5/8" nominal OD as selected for optimal performance.
- c. Tube wall thickness shall be 0.035" minimum.
- d. Fin thickness shall be 0.095" minimum.
- e. Fin density shall not exceed 12-FPI.

3. Bidirectional Flow

- a. Tubes shall be aluminum with integral fins.
- b. Tube diameter shall be 1" ID nominal.
- c. Tube wall thickness shall be 0.166" minimum.
- d. Fin density shall not exceed 12-FPI.

D. Working Fluid

1. Heat transfer fluid shall be selected on basis of heat pipe operating temperatures and compatibility with tube and wick materials.

E. Casing**1. Material and Gauge**

- a. Casing end supports and intermediate tube supports shall be G90 galvanized steel for heating only applications and type 304 stainless steel for applications that include cooling.
- b. Formed sheet metal components shall be 16-gauge minimum unless indicated otherwise in project documents. Thicker gauge shall be provided as required to maintain rigidity of larger and/or heavier coils.

2. Supports
 - a. Intermediate tube supports shall be provided for coils having finned length 48" or longer. Support shall be provided for each 48" tube length.
 - b. End supports and tube sheets shall have die formed belled tube holes or ferrules to minimize tube abrasion.
 3. Covers
 - a. End covers shall be provided to protect tube ends. Covers shall be same material and thickness as casing.
- F. Partition
1. Partition shall be provided to isolate adjacent airstreams to ensure no cross contamination.
 2. Partition shall be same material and thickness as casing. Partition shall be double wall foam filled construction.
 3. Partition shall be located in center of heat pipe coil unless indicated otherwise in project documents.
- G. Drain Pan
1. Drain pans shall be provided for coils that generate condensate in cooling mode. Drain pans shall be pitched drainable and shall include intermediate drain pans as required to prevent moisture carryover.
 2. Drain pans shall be stainless steel, double wall construction and shall be completely insulated with rigid two-part expanded urethane foam.
 3. Drain pans shall comply with applicable requirements of Section 23 73 23 – Custom Air Handling Units.
- H. Coil Dimensions
1. Coil sections shall not exceed 48" in height for coils that generate condensate in cooling mode. Height shall be further limited as required to prevent moisture carryover at design operating conditions. Manufacturer shall be engaged to make such determination.
- I. Bypass Dampers
1. Heat pipe coil bypass dampers shall be provided specified herein and as indicated on drawings.
 2. For linear side-by-side heat pipe coil automated dampers shall be provided in both air streams (i.e. outdoor/supply, return/exhaust) to allow bypass of air to reduce air pressure drop, facilitate economizer operation and provide frost control.
 - a. Dampers shall be sized such that combined airflow through bypass damper and coil is sufficient to provide 100% outdoor air economizer.
 3. For wrap around heat pipe coil bypass dampers shall be provided to reduce air pressure drop.
 4. Bypass dampers and actuators shall comply with requirements of *Section 23 09 13.43 – Control Dampers*.
 5. Damper actuation/automation shall be provided by Temperature Control Manufacturer.

J. Non-Standard Applications

1. For non-standard applications, component materials and thicknesses shall be selected for specific application. For corrosive vapor applications components exposed to airflow shall be type 304 or type 316 stainless steel or shall be phenolic coated at factory.

K. Controls

1. Control devices and programming shall be provided by Temperature Control Contractor in accordance with requirements of Section 23 09 23 – *Building Automation System (BAS) for HVAC* and Section 23 09 13 – *Instrumentation and Control Devices for HVAC*.
2. Manufacturer / Installing Contractor shall coordinate installation of controls and startup of AHU with Temperature Control Contractor.

2.11 OUTDOOR AIR HANDLING UNITS

A. Design of outdoor air handling unit shall be based upon “standard unit” as specified above.

B. Outdoor air handling unit shall satisfy specified requirements for indoor air handling unit plus additional requirements as identified below. Indoor air handling unit shall not be installed outdoors.

C. Outdoor unit shall incorporate reach-in enclosure as specified below.

D. Outdoor AHU shall be specifically designed for exposure to harsh weather conditions, including high wind, heavy snow loading, torrential rain and UV exposure. At minimum, requirements shall comply with applicable design and construction standards for geographic location.

E. Exterior surfaces:

1. Exposed steel components shall receive powder coat finish with UV protectant topcoat or backed enamel coating. Any scratches or defects in coating shall be touched up after installation per manufactures recommendations.

F. Enclosure, Reach-in

1. Exterior reach-in enclosure(s) shall be provided for each outdoor air handling unit. Multiple enclosures shall be provided as required to provide weather protection for pumps, piping, valves, controls, electrical, VFDs, and other components as required and/or as indicated.
2. Enclosures shall be sized and configured in manner that provides adequate access for operation, maintenance and replacement of housed components.
3. Enclosure structure, panels, doors and components shall be of same material and construction as balance of AHU. Enclosure shall satisfy specified requirements for base AHU. Exceptions:
4. One or more exterior doors with hinges and latches shall be provided as required for convenient access to components. Door(s) shall be sized and configured as required to satisfy specified access requirements.
5. Provision shall be made for heating and cooling/ventilating vestibule(s) as required to maintain temperature within allowable limits.

G. Component Location

1. AHU manufacturer shall determine location of field installed AHU components (e.g. VFD(s), electrical panels/devices, control panel(s)/devices, mechanical piping/devices) and shall coordinate with Installing Contractors as applicable.
2. Clear dimensions at electrical panels shall comply with requirements of NEC.

3. Provision shall be made to access drain piping and trap(s) for cooling coil condensate and other fluids as applicable. Piping and trap(s) shall be removable for cleaning and replacement of same.

H. Component Access

1. Outdoor AHU shall be configured to facilitate removal of coils and other internal components including fans, motors, energy recovery wheels, etc. without significant unit disassembly.

I. Roof

1. Roof shall cover entire unit.
2. Roof shall be sloped 1/4"/ft., minimum.
3. Roof deflection shall not exceed 1/240-th of span with applicable snow and wind loading.
 - a. Minimum design snow load shall be 25-lbs./sq. ft.
 - b. Minimum design wind speed shall be 90-MPH.

J. Intake plenum

1. Intake air plenum section shall be provided upstream of filter section to serve as stilling basin for rain and snow.
2. Outdoor air plenum shall be configured to yield constant air velocity across full face of filter bank such that maximum allowable airflow velocity is not exceeded at any point on downstream coil face.
3. Plenum shall be 3 ft. minimum length in direction of airflow.

K. Hoods and Louvers

1. Intake air hoods and louvers shall be provided to prevent ingress of rain and light powdery snow.
2. Airflow velocity across net free area of each hood opening shall not exceed 400-FPM. Velocity across net free area of louvers shall not exceed 500-FPM.
3. Intake hood shall be same material, thickness and coating as unit exterior.
4. 1/2" bird screen shall be provided over exterior face of each louver.

L. Doors

1. Doors shall be as specified for indoor AHU.

M. Electrical

1. Electrical and control devices shall be located within reach-in enclosure unless NEC dictates otherwise.
2. Exterior electrical enclosures shall be NEMA-3R.
3. Duplex outlet shall be GFI protected.

2.12 PLENUMS AND HOUSINGS

- A. Specifications provided herein shall be applied to following items as indicated within project documents to degree applicable
 1. Plenums, including exhaust air fan plenums
 2. Housings
 3. Casings

2.13 FACTORY TESTING

A. Air Leakage Test

1. Air handling units that require no disassembly and reassembly shall be tested for air leakage at factory prior to shipment.
2. Testing shall be in compliance with *ANSI/ASHRAE-Standard-111*.
3. Test pressure shall be 8" SP for positively pressurized unit sections and -8" SP for negatively pressurized unit sections unless indicated otherwise within project documents. Additionally, test pressure shall not be less than 1.25 x fan shut-off SP.
4. Cabinet air leakage shall not exceed 1% of design airflow rate at test pressure unless indicated otherwise within project documents.

B. Casing Deflection Test

1. In conjunction with air leakage testing, assembled unit shall be tested for casing deflection under leak testing conditions.
2. Under air leakage test conditions deflection of wall and top casing panels shall not exceed 1/240-th of span.

2.14 FACTORY PREP

- A. Units requiring field assembly shall be provided with factory blank-off panels at inlet openings, discharge openings, fan inlets and other locations required for field leak testing.

PART 3 – EXECUTION

3.1 EQUIPMENT LOCATION

- A. Indoor unit shall be located to allow full access to components.
- B. Indoor and outdoor unit shall be located no less than 24" to nearest wall or obstruction. Outdoor unit shall be located no less than 48" from edge of roof.

3.2 EQUIPMENT SUPPORT

A. Indoor Unit

1. AHU shall be placed upon and firmly anchored to steel reinforced concrete pad provided by Installing Contractor.
 - a. Pad shall be anchored into concrete floor.
 - b. Pad shall be 6" minimum thickness.
2. Curb shall extend 6" beyond fan support frame perimeter, minimum.
 - d. Pad elevation shall be adequate to accommodate installation of cooling coil condensate drain trap and/or steam condensate drip trap at adequate elevation above floor to ensure full drainage during "worst- case" unit operation.

B. Outdoor Unit

1. AHU support system shall be provided by Installing Contractor as specified herein and as indicated on drawings.
2. AHU shall be firmly mounted upon enclosed and insulated roof curb or open structural support system of adequate strength and rigidity to support full operating weight of unit.
 - a. Curb and/or support system shall include support of full perimeter of unit including vestibule(s).

3. Roof Curb Requirements
 - a. Roof curb shall place AHU at 12" minimum height above roof surface.
 - b. Roof curb shall provide uninterrupted enclosure around entire perimeter of unit.
 - c. Roof membrane termination and two piece counterflashing shall be provided as specified and detailed elsewhere within project documents.
 - d. Curb shall incorporate continuous welded stainless steel cap, 16-gauge minimum. Horizontal surface of cap shall not be penetrated in any manner. Penetrations may be made through vertical portions of cap only. Attachment of structural members or hardware to horizontal surface of cap shall be made by means of welding only. Welded attachments shall be stainless steel.
4. Open Support Structure Requirements
 - a. Open support structure and associated access platform shall provide 36" minimum clearance between bottom of structure and roof surface to facilitate roof maintenance and future replacement of roof membrane.
 - b. Attachment of roof membrane to vertical supports shall be provided as specified and detailed elsewhere within project documents.

3.3 INSTALLATION

- A. During site handling including crane transport, each factory assembled segment of air handling unit shall be structurally supported to prevent undo stress on unit components resulting in weakening or permanent deformation.
- B. AHU shall be assembled per Manufacturer's instructions and shall satisfy following requirements:
 1. AHU shall be leveled to ensure full drainage of coils by gravity and proper operation of rotating equipment. Support structure/pad shall be rigid and level prior to installation.
 2. Unit shall be firmly anchored to structural support in compliance with applicable code requirements.
 3. For AHUs supported upon concrete curb, base frame shall be grouted after leveling and anchoring.
 4. Shipping restraints shall be removed (e.g. spring isolators, coil headers).
 6. Ductwork connections shall be made specified herein and as indicated on drawings.
 - a. Ductwork connections to AHU plenums shall utilize expanded area transition fittings.
 7. Filter media shall be installed.
 8. Drain pans shall be piped individually to unobscured floor drain.
 - a. Existing drain shall be relocated as required.
 9. Clearances
 - a. Adequate clearance shall be provided for full functionality of access doors and removal/replacement of major components including coils and fans.
 - b. Adequate clearance shall be provided for installed piping.
 - c. Adequate coil pull area shall be provided.
 - d. Piping and other exterior system components shall be configured for disassembly without substantial modification to facilitate coil slide out. Coordination with other Contractors shall be provided.

10. Touch-up

- a. After installation is complete exterior coating, if provided, shall be touched up per Manufacturer's recommendations.

3.4 CLEANING

- A. When installation is complete, final cleaning of AHU shall be provided. AHU shall be cleaned to satisfaction of PSC and Owner. Cleaning requirement shall include coils and energy recovery wheel(s).
- B. *NADCA Standard ACR 2013 Assessment, Cleaning and Restoration of HVAC Systems* shall be utilized by AE as basis for determining need for cleaning, extent and methodology to be employed.
- C. Only non-hazardous non-toxic cleaning agents and materials shall be used. MSDS cut sheets shall be provided upon request.

3.5 STARTUP

- A. Prior to start-up Installing Contractor and Manufacturer's service technician(s) shall verify following items have been completed:
 1. Unit is clean to satisfaction of AE and Owner.
 2. Spring isolator shipping restraints removed and components leveled.
 3. Interconnections completed (i.e. electrical and control wiring, piping, casing joints, bolting, welding, etc.). Power wiring including motor starters and disconnects serving unit completed.
 4. Water and steam piping connections completed, hydrostatically tested and water flow rates set in accordance with capacities specified.
 5. Ductwork connections completed and ductwork pressure tested.
 6. Temperature control and safety systems completed and functional.
 7. Dampers fully operational.
 8. Filter media installed and clean.
 9. Bearings properly lubricated.
 10. Belts properly aligned and tensioned.
 11. Fan(s), energy recovery wheel(s) turn freely.
 12. Energy recovery wheel purge(s) and seals properly adjusted and secured.
 13. Condensate drain trap and piping properly installed.
- B. Labeling
 1. After ventilating system balancing has been completed by TAB Contractor embossed label shall be permanently applied to front cover of VFD indicating airflow rate (CFM) and associated VFD output frequency (Hertz) as indicated within balance report.

Note to Contractor: This has not been a common practice but shall be performed before final approval.

3.6 FIELD TESTING

A. Air Leakage Test

1. Field assembled air handling units shall be tested for air leakage after assembly and prior to operation.

2. Testing shall be in compliance with ANSI/ASHRAE-Standard-111.
 3. Test pressure shall be 6" SP for positively pressurized unit sections and -6" SP for negatively pressurized unit sections unless indicated otherwise within project documents. Additionally, test pressure shall not be less than 1.25 x fan shut-off SP.
 4. Cabinet air leakage shall not exceed 1% of design airflow rate at test pressure unless indicated otherwise within project documents.
 5. Modifications shall be made as required to pass test. Modifications shall be approved by AE and Owner and shall be at Contractor's expense. Use of caulk and other sealants shall be minimized. Responsibility for providing corrective modifications falls jointly upon Ventilating Contractor and AHU Manufacturer.
 6. Positive pressure test may be substituted for negative test only with approval of AE and Owner.
- B. Field Balance
1. Field balance of fan/motor assembly not required unless, if in judgment of AE or Owner, vibration level is deemed questionable or unacceptable. In such case, vibration analysis and balancing shall be performed by qualified technician as specified above in section entitled *Factory Run Test / Balance*.
 - a. Referenced section indicates maximum allowable fan vibration level as follows:
 - 1) Belt-driven fans: 0.15-in/sec peak velocity, filter installed
 - 2) Direct drive fans: 0.10-in/sec peak velocity, filter installed

END OF SECTION 237313

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 238216 - AIR COILS

PART I - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Chilled water coils
 - 2. Hot water coils
 - 3. Zone hot water re-heat coils
 - 4. Heat pipe coils

1.2 DEFINITIONS

- A. Hydronic System: Non-potable water-based heat transfer system, excluding steam. Hydronic systems include heating hot water, chilled water, chilled beam and condenser water systems.
- B. Manufacturers: In Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Basis of Design: Products indicated by manufacturer and model within the contract documents are considered the Basis of Design. This includes plan drawings, drawing details, schedules, specifications, etc. Subject to compliance with requirements, provide the basis of design products unless the manufacturer provisions (below) or substitution provisions within the contract documents are complied with.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Non basis of design products which are listed by manufacturer name only may be considered for bid. By submitting a bid based on a non-basis of design product, the contractor acknowledges performance of a comprehensive review of the collateral impacts to themselves and to other trades. Contractor use of non-basis of design products shall not be the basis for additional time or costs to the Owner.
 - 3. Non-listed Products: Subject to compliance with requirements, Products not indicated within the Contract Documents shall not be used unless positively reviewed within a substitution request.
- C. Abbreviations:
 - 1. %: Percent.
 - 2. ACR: Assessment, Cleaning and Restoration
 - 3. AHRI: Air-conditioning, heating, and refrigeration institute.
 - 4. AHU: Air-handling unit.
 - 5. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers.
 - 6. ASTM: The American Society for Testing of Materials.
 - 7. BAS: Building Automation System.
 - 8. CDA: Copper Development Association.
 - 9. CFM: Cubic feet per minute.
 - 10. CHW: Chilled water
 - 11. DB: Dry bulb temperature.
 - 12. E.g.: Exempli gratia "for example."

13. Etc.: Et cetera “and other similar things”
14. EWT: Entering water temperature.
15. F: Degrees Fahrenheit.
16. FPI: Fins per inch.
17. FPS: Feet per second.
18. FT or ‘: Feet.
19. HVAC: Heating, Ventilating, and Air-conditioning.
20. HW: Heating hot water.
21. I.e.: Id est “in other words.”
22. IFB: Integral face and bypass.
23. In or “: Inches.
24. LWT: Leaving water temperature.
25. MPT: Male pipe thread.
26. MSDS: Material safety data sheet.
27. NADCA: National Air Duct Cleaners Association.
28. OA: Outside air.
29. OD: Outside diameter.
30. PSIG: Pounds-per square-inch gauge pressure.
31. SMACNA: Sheet Metal and Air-conditioning Contractor’s National Association.
32. T: Temperature.
33. UIS: The University of Illinois at Springfield.
34. WB: Wet bulb temperature.
35. WC: Water column.

1.3 QUALITY ASSURANCE

- A. Air coils shall be AHRI certified, assuring validity of published performance ratings.
- B. Installation, start-up and operation shall be in compliance with Manufacturer’s recommendations and installation, operation, and maintenance manuals.

1.4 SUBMITTALS

- A. Shop drawings including but not limited to following:
 1. General description
 - a. Coil type, configuration, number of rows
 2. Scale drawings including plan and elevation views:
 - a. Pipe connections, shown in each view
 - b. Pertinent dimensions
 - c. Dry and operating weights
 3. Component data:

- a. Tubes, including size, materials, wall thickness
 - b. Fins, including type, materials, thickness, fin density (FPI), fin profile
 - c. Headers, including materials, thickness, connection size
 - d. Casing, including materials, metal gauge
4. Performance parameters:
- a. Water side:
 - (b) Fluid type (water, % glycol), fluid capacity
 - (c) Fluid flow rate, tube velocity, pressure drop
 - (d) EWT, LWT
 - b. Air side:
 - (a) Airflow rate, face velocity, pressure drop
 - (b) Entering air DB/WB, leaving air DB/WB
 - (c) Total, sensible capacities
5. AHRI certification seal or equivalent

1.7 DELIVERY, STORAGE AND HANDLING

- A. Coils, especially finned areas, shall be protected from physical damage during delivery, storage and handling.
- B. Coils shall be protected from exposure to dust, debris and fluids.
- C. Header connections, including vents and drains, shall be capped to protect pipe threads.

1.8 WARRANTY

- A. Air coils shall be warranted by Manufacturer to be free from defects in material and workmanship and perform as specified for period of one year from date of startup or 18-months from date of delivery whichever occurs first. Manufacturer shall repair or replace unit or defective component(s) at no cost to Owner. Repaired unit shall be like new with no cutting, patching or notable modification as determined by AE or Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All coils shall be rated in accordance with *AHRI Standard 410* and shall bear the AHRI stamp or symbol.
- B. All coils including those associated with central station equipment (e.g. air handling units, dedicated outdoor air units, associated heat recovery equipment) of any make shall fully satisfy specifications herein.
- C. Project-specific performance and construction requirements shall be as scheduled on drawings or as otherwise indicated in project documents.
- D. Large coils located outside air handling units (e.g. duct-mounted, plenum mounted) shall comply with all requirements for AHU mounted coils.
- E. Bypass dampers, if provided with coil, shall comply with *Section 23 09 13.43 – Control Dampers*. Not applicable to integral face and bypass dampers.

2.2 WATER COILS

A. General

1. Coil shall be of staggered tube, continuous parallel plate fin design.
2. Tubes shall be expanded into fins to form permanent bond.
3. Circuiting and connections shall be arranged to provide counter-flow of water and air.
4. "Turbulators" not allowed.
5. Coil shall be supplied with vent at high point and drain at low point of tube bundle.
6. Coil shall be fully drainable by gravity.
7. Coil shall have same end connections unless indicated otherwise in project documents.
8. To ensure maximum heat transfer over wide range of flow rates, coils shall be selected for fluid velocity through tubes as high as possible without exceeding 6-FPS. In no case shall fluid velocity exceed 8-FPS. Design fluid velocity shall be no less than 3-FPS.
9. Water pressure drop shall be as scheduled but shall not exceed 20-ft. w.c.
10. Coil thermal performance shall be determined based upon fluid media indicated on schedule (e.g. water, 30% ethylene glycol solution).
11. If not otherwise scheduled, coil performance shall be based upon following parameters:
 - a. 100% water for standard temperature air applications.
 - b. 30% ethylene glycol solution for applications with freeze potential (typically finned tube elements, convectors and AHU preheat coils).
12. Coil shall be AHRI rated with 0.0005 fouling factor.
13. Headers outside airflow shall be insulated in same manner as piping.
14. Individual coil sections (i.e. sections with continuous plate fins) shall not exceed 48" in height.

B. Tubes:

1. Tubes shall be seamless copper, 5/8" nominal OD with 0.035" wall thickness minimum.
2. Return bends shall be attached to tubes as independent fittings. "Hairpin" tube return design without separate return bend fittings is not allowed. Return bends shall be one nominal wall thickness heavier than circuit tubing.

C. Fins:

1. Fins shall be aluminum for standard applications, 0.0095" minimum thickness.
2. To facilitate cleaning, fins shall be flat or have low continuous corrugation.
3. Maximum fin density shall not exceed 12-FPI for flat fins, 10-FPI for low corrugation fins.

D. Headers:

1. Coil headers shall be seamless copper, type K minimum. Cast iron headers not allowed.
2. Each header shall have vent and drain.
3. Connection stubs shall be seamless copper or red brass with MPT connections. Stubs shall be capped for shipping purposes.

E. Casing and Supports:

1. Casing shall have flanged connections unless indicated otherwise in project documents or dictated by specific application.

2. Casing, end supports and intermediate tube supports shall be G90 galvanized steel for heating applications and type 304 stainless steel for cooling applications.
3. All formed sheet metal components shall be 16-gauge minimum. For large and/or heavy coils casing shall be thicker gauge as required to provide adequately rigidity.
4. Intermediate tube supports shall be provided for coils having finned tube length 48" or longer. Support shall be provided for each 48" tube length.
5. End supports and tube sheets shall have die formed belled tube holes or ferrules to minimize tube abrasion.

F. Pressure Test:

1. Completed coil assembly shall be pneumatically leak tested at 300-PSIG minimum under water and shall be guaranteed for 200-PSIG working pressure.

G. Non-Standard Applications:

1. For non-standard applications, all component materials and thicknesses shall be selected for specific application.

H. Manufacturers:

1. Heatcraft
2. Marlo
3. Aerofin
4. Coil Master
5. Armstrong Hunt
6. Nortek
7. Note: At the Contractor's option, coils may be provided by the equipment manufacturer listed in separate sections. Coils provided by the equipment manufacturer shall meet the full requirements of this section.

2.3 CHILLED WATER COILS

A. Coil shall satisfy requirements of *WATER COIL* section above with additional requirements:

1. Casing, end supports and intermediate tube supports shall be fabricated from type 304 stainless steel.
2. Fasteners shall be stainless steel.
3. Individual coil section (i.e. sections with continuous plate fins) shall not exceed 48-inch face height. Height shall be further limited as required to prevent moisture carryover at design operating conditions. Manufacturer shall be engaged to make such determination.
4. Air velocity through "net free area" of coil face shall be no greater than 450-FPM.
5. Air pressure drop shall not exceed 1.0-in. w.c. at design CFM airflow.
6. Performance of cooling coils served by campus central chilled water system shall be based upon following parameters:
 - a. Entering chilled water temperature shall be 45-F.
 - b. Leaving chilled water temperature shall be 57-F minimum.

2.4 HOT WATER COILS

- A. Coil shall satisfy requirements of WATER COIL section above with additional requirements:
 - 1. Air velocity through net free area of coil shall be no greater than 600-FPM.
 - 2. Air pressure drop shall not exceed 0.5-in. w.c. at design CFM airflow.
 - 3. If not otherwise scheduled, coil performance shall be based upon following parameters:
 - a. Entering fluid temperature shall be 180-F.
 - b. Leaving fluid media temperature shall be 160-F.

2.5 ZONE HOT WATER REHEAT COILS (or BOOSTER COILS)

- A. Coil shall satisfy requirements of HOT WATER COIL section above with following modifications:
 - 1. Tubes shall be 5/8" nominal OD with 0.025" wall thickness minimum.
 - a. Alternate: Tubes may be 1/2" nominal OD with 0.020" wall thickness minimum.
 - 2. Fin thickness shall be nominal 0.008" minimum.
 - 3. Headers and connection stubs shall be type L copper minimum with MPT connections. Stubs shall be capped for shipping purposes.
 - 4. Fluid pressure drop shall not exceed 20-ft. w.c.
 - 5. Air velocity through full face area of coil shall be no greater than 600-FPM.
 - 6. Air pressure drop shall not exceed 0.25-in. w.c. unless indicated otherwise in project documents.

2.6 HEAT PIPE COILS

A. General

- 1. Linear-Tube Heat Pipe Coils:
 - a. Shall provide passive heat energy exchange between two counter-flow air streams.
 - b. Shall be configured with tubes horizontal or vertical as shown on drawings or otherwise indicated in project documents.
 - c. Shall be affixed and shall have no requirement for tilting to ensure specified performance in all operating conditions.
 - d. Shall be single unit for heat exchange between adjacent airstreams
 - e. Shall be matched coil set with interconnecting piping for heat exchange between remote airstreams.
- 2. U-framed "wrap-around" heat pipe coils:
 - a. Shall provide dehumidification of air at cooling coil location.
 - b. Shall incorporate adequate access between heat pipe and cooling coil on each side of cooling coil.
 - 1) Face-to-face clear dimension on each side of coil shall typically be 30" minimum but in no case shall be less than 24".

B. Configuration

- 1. Series Flow:
 - a. Heat pipe tubes shall be configured in series circuits such that liquid and vapor travel in same direction around circuit making wicking and capillary action unnecessary.

- b. Basis of Design: Heat Pipe Technologies
- 2. Bidirectional Flow (Conventional):
 - a. Individual heat pipe tubes shall incorporate interior tube wall enhancements for wicking of heat transfer fluid via capillary action for transfer of liquid and gas in opposite directions.
 - b. Basis of Design: Innergy tech, Inc. or comparable product by the following:
 - 1) Thermofin
- C. Finned Tubes:
 - 1. Tubes shall be individually processed, charged, hermetically sealed and factory tested for leakage.
 - 2. Series Flow:
 - a. Tubes shall be rigid copper tubing expanded into aluminum plate-type fins to form permanent bond.
 - b. Tube diameter shall be 1/2" or 5/8" nominal OD as selected for optimal performance.
 - c. Tube wall thickness shall be 0.035" minimum.
 - d. Fin thickness shall be 0.095" minimum.
 - e. Fin density shall not exceed 12-FPI.
 - 3. Bidirectional Flow:
 - a. Tubes shall be aluminum with integral fins.
 - b. Tube diameter shall be 1" ID nominal.
 - c. Tube wall thickness shall be 0.166" minimum.
 - d. Fin density shall not exceed 12-FPI.
- D. Working Fluid:
 - 1. Heat transfer fluid shall be selected on basis of heat pipe operating temperatures and compatibility with tube and wick materials.
- E. Casing:
 - 1. Material and Gauge:
 - a. Casing end supports and intermediate tube supports shall be G90 galvanized steel for heating only applications and type 304 stainless steel for applications that include cooling.
 - b. All formed sheet metal components shall be 16 gauge minimum unless indicated otherwise in project documents. Thicker gauge shall be provided as required to maintain rigidity of larger and/or heavier coils.
 - 2. Supports:
 - a. Intermediate tube supports shall be provided for coils having finned length 48" or longer. Support shall be provided for each 48" tube length.
 - b. End supports and tube sheets shall have die formed belled tube holes or ferrules to minimize tube abrasion.
 - 3. Covers:
 - a. End covers shall be provided to protect tube ends. Covers shall be same material and thickness as casing.

F. Partition:

1. Partition shall be provided to isolate adjacent airstreams to ensure no cross contamination.
2. Partition shall be same material and thickness as casing. Partition shall be double wall foam filled construction.
3. Partition shall be located in center of heat pipe coil unless indicated otherwise in project documents.

G. Drain Pan:

1. Drain pans shall be provided for coils that generate condensate. Drain pans shall be pitched drainable and shall include intermediate drain pans as required to prevent moisture carryover.
1. Drain pans shall be stainless steel, double wall construction and shall be completely insulated with rigid two-part expanded urethane foam.

H. Coil Dimensions:

1. Coil sections shall not exceed 48" in height for coils that generate condensate in cooling mode. Height shall be further limited as required to prevent moisture carryover at design operating conditions. Manufacturer shall be engaged to make such determination.

I. Bypass Dampers:

1. Heat pipe coil bypass dampers shall be provided as shown on drawings.
2. For linear side-by-side heat pipe coil automated dampers shall be provided in both air streams (i.e. outdoor/supply, return/exhaust) to allow bypass of air to reduce air pressure drop, facilitate economizer operation and provide frost control:
 - a. Dampers shall be sized such that combined airflow through bypass damper and coil is sufficient to provide 100% outdoor air economizer.
3. For wrap around heat pipe coil bypass dampers shall be provided to reduce air pressure drop.
4. Bypass dampers and actuators shall comply with requirements of Section 23 09 13.43 – Control Dampers.
5. Damper actuation/automation shall be provided by Temperature Control Manufacturer.

J. Non-Standard Applications:

For non-standard applications, all component materials and thicknesses shall be selected for specific application.

K. Controls:

1. All control devices and programming shall be provided by Temperature Control Contractor in accordance with requirements of *Section 23 09 23 – Building Automation System (BAS) for HVAC* and *Section 23 09 13 – Instrumentation and Control Devices for HVAC*.
2. Manufacturer / Installing Contractor shall coordinate installation of controls and startup of AHU with Temperature Control Contractor.

PART 3 – EXECUTION

3.1 COIL PROTECTION

A. Coils shall be protected from physical damage during delivery, storage and handling:

1. Coils shall be protected from exposure to dust, debris and fluids.

2. Header connections shall be capped to protect pipe threads.

3.2 PIPING

- A. Unions/flanges shall be installed at each coil pipe connection as applicable.
- B. For coils located in air handling units, piping and other exterior system components shall be configured to facilitate coil removal via slide out through wall of unit.
- C. Air vents and drains, complete with valves, shall be provided for each water coil.
- D. Headers outside airflow shall be insulated in same manner as piping.
- E. Cooling coil condensate drain lines shall be trapped and piped to drain independently.
- F. Hot water coils shall be piped with adequate offsets to minimize stress at header connections due to thermal expansion. If not practical to provide adequate flexibility in this manner, flexible pipe connectors may be used although their use is generally discouraged.

3.3 LOCATION / ACCESS

- A. Adequate access shall be provided for convenient inspection and cleaning of coils.
- B. Installed distance between upstream and downstream of coil faces shall typically be 30" minimum. In no case shall space between coils be less than 24". Such requirement applies to space between U-framed "wrap-around" heat pipe coils, both sides of associated cooling coil.
- C. Adequate clearance shall be maintained relative to adjacent structures and/or building systems to allow coil replacement without alteration of any system or component. Adequate access shall be provided at coil valves and piping.
- D. Coils, especially cooling coils, shall not be installed above valuable furnishings, electrical equipment, electronic devices, etc. where leakage could result in costly damage. If impractical to do so, provision of protective drain pan is required.

3.4 INSTALLATION

- A. Unless otherwise indicated within project documents, coil casings shall have flanged connections and shall be secured with threaded fasteners. Sheet metal screws shall not be used.
- B. Fasteners and hardware shall be same material as connected components. Where connected components are dissimilar material, stainless steel fasteners shall be used.
- C. Structural supports shall be provided for stacked coils within air handling unit or plenum. Supports shall be configured to facilitate removal of coil sections by sliding out through wall of unit.
- D. When two or more cooling coils are stacked in an assembly, intermediate drain pans shall be provided.
- E. Water and steam coils shall be installed dead level to facilitate full drainage by gravity.
- F. Heat pipe coils shall be positioned as recommended by Manufacturer to ensure optimal circulation of heat transfer fluid.
- G. Sheet Metal blank off panels shall be provided to prevent bypass airflow.
- H. Properly configured duct transitions shall be provided at duct mounted coils. Transitions shall be in compliance with applicable *SMACNA Standards*.
- I. Coil fins shall be combed and straightened after installation is complete.

3.5 ENTERING AIR REQUIREMENT

- A. Air streams of differing temperature shall be thoroughly mixed prior to entering coils.

- B. During operation, coils shall be exposed to filtered air only. Filters shall be provided.
- C. Coil fins shall be combed and straightened after installation is complete.

3.6 CLEANING

- A. Coils shall be cleaned to satisfaction of AE and Owner.
- B. *NADCA Standard ACR 2013 - Assessment, Cleaning and Restoration of HVAC Systems* shall be utilized by AE as basis for determining need for cleaning, extent thereof and methodology to be employed.
- C. Only non-hazardous non-toxic cleaning agents and materials shall be used. MSDS cut sheets shall be provided upon request.

END OF SECTION 238216

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 260000 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

- 1.1 All electrical devices, equipment and systems, including those not specifically addressed in these *Standards*, shall conform to the 2017 National Electric Code (NEC), the UIS Facilities Standards, the National Board of Fire Underwriters, and any state and local requirements, laws and ordinances as may be applicable.

PART 2 - PRODUCTS

- 2.1

PART 3 - EXECUTION

- 3.1

END OF SECTION 260000

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 260513 - MEDIUM VOLTAGE POWER CABLE

PART I - GENERAL

1.1 SECTION INCLUDES

- A. This specification describes single conductor EPR (Ethylene-propylene-rubber) insulated, shielded power cables for use in grounded neutral circuits not exceeding 5,000 or 15,000 volts phase-to-phase at conductor temperatures of 105 degree Centigrade for continuous normal operation, 140 degree Centigrade for emergency overload conditions, and 250 degree Centigrade for short-circuit conditions. Cables shall be type MV-105 or higher, otherwise, they are intended for general purpose power cable applications in wet or dry locations, including conduit, duct, direct burial, and aerial installation.

1.2 QUALITY ASSURANCE

- A. The following standards shall form a part of this specification.
 - 1. UL Standard 1072 for Medium-Voltage Solid-Dielectric Cable.
 - 2. ICEA S-97-682 *Utility Shielded Power Cable Rated 5-46 kV*
 - 3. NFPA, NEC
- B. Cable shall be tested in accordance with ICEA S-97-682, UL Standard 1072, and International Electrical Testing Association – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (Refer to the medium voltage cable DC testing requirements.)
- C. The medium voltage power cable shall have 20 year performance record in utility and industrial applications.

1.3 SUBMITTALS

- A. Submit in accordance with submittal procedures as described in *Division 01*.
- B. Cable Splicer: Provide the Owner with the names of the cable splicers to be employed, together with satisfactory proof that each splicer has had at least three years' experience in splicing high-voltage cables and is experienced with the type and rating of cables to be spliced.

PART 2 - PRODUCTS

2.1 MEDIUM VOLTAGE CABLE CONDUCTORS

- A. Manufacturers: Cable shall be manufactured by Okonite, General Cable, Aetna, or Kerite.
- B. Conductor: The cable shall be single-conductor, AWG sized as noted on the drawings. The conductor material shall be Annealed copper compact stranded per ASTM B-496
- C. Strand Screen: The conductor shall be covered with Extruded semiconducting EPR strand screen. Meets or exceeds the electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, AEIC CS8, CSA C68.3 and UL 1072.

- D. Insulation: Directly over the conductor shielding shall be applied a homogenous wall of EPR insulation. Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, AEIC CS8, CSA C68.3 and UL 1072. The minimum average insulation thickness is 115 mills for 5/8 KV and 220 mills for 15KV.
- E. Insulation Screen: Extruded semiconducting EPR insulation screen applied directly over the insulation. Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, AEIC CS8, CSA C68.3 and UL 1072.
- F. Shield: 5 mil bare copper tape helically applied with 25% nominal overlap.
- G. Jacket: Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, CSA C68.3 and UL 1072 for chlorinated polyethylene jackets. UL listed as Type MV-105, sunlight resistant and for use in cable tray in accordance with UL 1072. CSA C68-3 listed and rated FT4 (1/0 AWG and larger) and -40°C.

2.2 IDENTIFICATION

- A. Identification: All cable shall be identified by means of surface printing or indenting, indicating manufacturer, size, insulation type, voltage rating, and UL designations.

2.3 MEDIUM VOLTAGE GROUND CONDUCTOR

- A. Ground Conductor: All medium voltage power circuits in duct shall be paralleled by a grounded conductor intended to minimize fault current in power cable shields. The ground conductor shall be copper, THWN insulation, rated at 600 volts, and the size shall be in accordance with the latest revision of the NEC, or the drawings, whichever is larger.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturer's Recommendations: This cable is for extension of campus electric distribution system to buildings and shall be installed in strict accordance with manufacturer recommendations. Particular attention to manufacturer requirements about installation in cold weather shall be given to bending radius and pulling tension.
- B. Type MV cable shall be installed, terminated, and tested by qualified persons. Work shall follow IEEE 576-2000, *Recommended Practice for Installation, Termination, and Testing of Insulated Power Cables as Used in Industrial and Commercial Applications*.
- C. Whenever work is done in an enclosure, manhole, switchyard, etc., containing energized parts, all work shall be done in compliance with the safety regulations in the current edition of NFPA 70E: *Standard for Electrical Safety in the Workplace*.
- D. Rigid Conduit or Encased Ducts: Cables shall be installed in rigid conduit inside buildings and in concrete encased ducts outside of buildings.
- E. Direct Buried High Voltage Cable: High Voltage direct buried cable maybe used anywhere as long as approved in writing by the Owner. Direct buried cable shall be a three conductor cable, and shall be terminated using 3M QT-III termination kits, or approved equal, with break-out boot.
- F. Splices: Wye splices are not acceptable. No splices shall be installed in duct runs or conduits. Splices shall be made with 3M QT-III cold-shrink splice kits, or approved equal.

- G. Cable Protection: Duct shields are required for protection of the cable, and the cable shall be placed on heavy duty fiberglass cable rack arms. Cables shall be secured to fiberglass racks, after fireproofing is installed, using plastic cable ties or other approved method.
- H. Fireproof: Cables shall be fireproofed in manholes, vaults, switchgear, and other locations where exposed. 3M Fire-Retardant Electric Arc Proofing Tape 77, or approved equal. Apply 77 tape in half-lapped layers. Since the 77 Series is not adhesive coated, it must be held in place after wrapping with bands of 3M Electrical Tape 69.
- I. Labels: Cables shall be labeled with plastic engraved plates with minimum 1/2" letters in manholes and other locations where exposed. Secure to cables with plastic cable ties or other approved method. Consult with F&S for conductor label designations and colors.
- J. Cable Terminations:
1. Modular Molded Rubber Termination: ANSI/IEEE 386. Kit form, suitable for use with cable specified, including stress cone, ground clamp, connector, rubber cap, and aerial lug. 3M Modular Splicing System – such as 5815 Series, or approved equal.
 2. Indoor Cold Shrink Terminations: one-piece, non-skirted, silicone rubber terminations, qualified as IEEE Standard 48-1990 Class 1 for indoor and weather-protected applications; Terminating of all 5, 8.7, 15, 25/28 and 35kV shielded power cables, indoors and in weather-protected equipment, shall be performed in accordance with instructions included in the termination kit. The termination must be of a pre-stretched cold shrink design, installed without the application of a heat source. Kits shall be 3M QT-III, or approved equal.
 3. Outdoor Weather-Exposed Cold Shrink Terminations: one-piece, skirted, silicone rubber terminations, qualified as IEEE Standard 48-1996 Class 1 for outdoor weather-exposed applications. The termination shall be of a skirted design, constructed of tracking resistant silicone rubber, and shall be performed in accordance with instructions included in the termination kit. The termination must be of a pre-stretched cold shrink design, installed without the application of a heat source. Kits shall be 3M QT-III, or approved equal.
 4. Motor Terminations: Terminations for 5KV motors shall use 3M Series 5300 8KV Motor Lead Pigtail Splice kits, or approved equal. The splice's main component, the lug or splice cover, is made from EPDM rubber either as a slip-on or as a cold shrink insulator. Mastic is used for the moisture seal on the pigtail kits. The 5/8 kV kits designed for shielded feeder cables utilize a high dielectric constant (K) stress control material or the feeder cable's electrical stress control. These kits are designed to be used with copper compression, one or two hole lugs. After being crimped onto the cables, the lugs are bolted together in an inline or pigtail configuration, then insulated and sealed with the motor lead splicing kits. Kits shall be installed per manufacturer's instructions.
 5. Loadbreak Elbows: Where required, loadbreak elbows shall be 3M 5810 Series, Cooper Power Systems, or approved equal by. Elbows will be 200 ampere, and molded using high quality EPDM insulation. Loadbreak Elbows will be a fully shielded and insulated plug-in separable connector for connecting 5 to 25 kV underground cables to transformers, switchgear and junctions equipped with loadbreak bushings.
- K. Lugs: Use or irreversible type lugs on all terminations. Standard mechanical lugs are not acceptable.

3.2 PROTECTION

- A. Protect Cable: During installation cables shall be protected from physical damage and infiltration of water.
- B. Damaged Cable: Damage to cable or observed presence of water inside of the cable shall cause the cable to be rejected and replaced at the Contractor's expense.
- C. Handling and Storage: Cables shall be transported and stored on circular reel legs and not stored on their side.

3.3 MEDIUM VOLTAGE GROUND CONDUCTOR

- A. Shared Duct: This cable is necessary to limit power cable shield current when power cable failures occur. Between manholes, the cable shall be installed in the same duct cell as power circuits.
- B. Splices: Splices in duct runs are unacceptable.
- C. Bonding: At source and load ends of power cables, this cable shall be bonded to source and building grounding systems. Bonding shall be done with materials that are UL listed for grounding purposes. Where this grounding conductor is over 2000 feet in length and passes through manholes, it shall be bonded to the ground rod in the manholes every 2000 feet. Do not bond to ground rods on lengths under 2000 feet. The power cable shields of all spliced power cables shall also be bonded to the ground conductor.

END OF SECTION 260513

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 260519 - CONDUCTORS AND CABLES

PART I - GENERAL

1.1 RELATED DOCUMENTS

- A. *Section 26 05 33 - Raceways*
- B. *Section 26 05 34 - Low Voltage Raceways*

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Copper Conductors: All wire and cable shall have copper conductors with minimum of 98 percent conductivity, except for overhead service conductors which operate at less than 600 volts.
- B. Overhead Service Conductors: Overhead service conductors operating at less than 600 volts may be appropriately sized aluminum with waterproof connections. Overhead service conductors shall be in a triplex or quadraplex configuration with a messenger of adequate strength for wind loading and span.

2.2 FIRE ALARM CONDUCTORS AND CABLES

- A. Fire alarm system initiating circuits: Type TFFN stranded wire at least size 18AWG, but no larger than 14 AWG THHN. Solid wire shall not be permitted.
- B. Fire alarm system notification appliance circuit (NAC) wiring: Type THHN stranded wire size 14 AWG. Solid wire shall not be permitted.
- C. Where approved jacketed cable is used, conductors shall be stranded and sized in accordance with 2.2(B) and 2.2(C) of this section.

2.3 OUTDOOR CABLE

- A. Outdoor: All exterior cable shall be dual rated type RHW-2/USE-2. All conductors shall be installed in conduit or duct. Cable shall be 600 Volt rated. Cable shall comply with U.L. 44 (for Type RHW-2) and U.L. 854 (for Type USE-2). Cables shall be rated for use at 90°C in both wet and dry locations and be suitable for use in conduit, underground service entrance cable and direct burial applications.
- B. Minimum Size: Minimum size for all outdoor underground conductors shall be 6AWG stranded.
- C. Splicing and Terminating: All outdoor splices and terminations shall be by UL Listed means, rated for wet locations and/or direct-buried use.

2.4 INDOOR CABLES AND CONDUCTORS

- A. Indoor Cables and Conductors shall be THHN/THWN-2, or XHHW-2; installed in conduit; for services, feeders, and branch circuits, as specified in the National Electrical Code. Voltage rating for all applications is 600 volts. Temperature rating in wet or dry locations of 90° C.
- B. Minimum size shall be 12AWG.

- C. All conductors shall be stranded construction.

2.5 VARIABLE FREQUENCY DRIVE CABLE

- A. Conductors between a VFD and the motor shall be a Tray Cable rated assembly of 3 phase conductors, 3 symmetrical full-size equipment ground conductors, and an overall spiral copper tape shield providing 100% shielding.
- B. Installation: VFD cable shall be installed in raceway. Proper cable bending radius requirements must be followed to avoid damage to the cable. All cables must be installed and terminated per manufacturer instructions.
- C. Installation of 6' or less: By permission, VFD cable runs of 6 feet or less can be run without raceway, if Armored VFD cable is used, with UL listed termination fittings.
- D. Listings. Cable shall meet the following standards:
 - 1. 600V UL 1277 Type TC-ER per 2005 NEC Article 336; 1000V CSA AWM I/II A/B FT4; Bare Copper Conductors; Class B Stranding per ASTM; XLPE Insulation XHHW-2 Rated Circuit Conductors; 90°C Wet/Dry; Class I & II; Division 2 Hazardous Locations; UL 1685 Vertical Tray Flame Test; IEEE 1202/383 Vertical Tray Flame Test; UL Direct Burial; RoHS Compliant; CE Approved
- E. Cables shall be:
 - 1. Belden Basics® VFD Cable
 - 2. Service Wire ServiceDrive® ASD/VFD Shielded Tray Drive Cable

2.6 Building Automation System Conductors

- A. All conductors used in BAS systems for digital inputs, digital outputs, analog inputs, and analog outputs shall be plenum rated (CMP), minimum 18 AWG stranded bare copper conductors, maximum capacitance 70 pF/ft, Low Smoke Polyvinyl Chloride jacket with ripcord, conductors cabled, Overall tape shield and drain wire, sequential footage marking every two feet. Belden 6300FE, Windy City Wire 002320-S, or approved equal. NEC grounded conductor identification color code requirements must be considered when selecting cables.
- B. Any BAS conductors that are considered Class 2 or Class 3 by NEC Article 725 shall be installed with separation from Power conductors per the requirements of NEC Article 725.

PART 3 - EXECUTION

3.1 BUILDING WIRE

- A. Enclosed Raceways: All wiring in buildings shall be installed in metallic enclosed raceways. For remodeling, some types of low voltage wiring may be installed exposed. See *Section 26 05 34 - Low Voltage Raceways* for conditions. Limit one network per conduit.
- B. Stranded Conductors: All wire shall have stranded conductors.
- C. Wire Size: All field installed branch circuit power and lighting wiring shall be 12 AWG minimum. Branch Circuit Conductors shall be sized to maintain no more than 3 percent voltage drop at the

farthest outlet. Maximum total voltage drop on both Feeders and Branch Circuits to the farthest outlet shall not exceed 5 percent.

- D. Control Wiring: Field installed control wiring shall be 14 AWG, stranded, 600 volt, with proper size crimp lugs at termination screws.
- E. Connection to Motors: Final wiring connection to all motors shall be with stranded wire. Connection to motors from Variable Frequency Drives shall use the VFD cable in 2.5.
- F. Vertical Raceways: For cables in vertical raceways, appropriate support shall be provided to minimize damage to cable insulation.
- G. Color Code: All branch and feeder wiring in a new building shall be in accordance with an established color code. Color Code for a building shall be posted at each panelboard, per NEC Article 210. Wiring installed during remodeling shall be in accordance with the color code established when the building was constructed. Otherwise, the following color code shall be utilized:

- 1. 120/280V Systems

- A Phase – Black
 - B Phase – Red
 - C Phase – Blue
 - Neutral – White
 - Ground – Green

- 2. 277/480V Systems

- A Phase – Brown
 - B Phase – Orange
 - C Phase – Yellow
 - Neutral – Grey
 - Ground – Green

END OF SECTION 260519

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 260526 - GROUNDING AND BONDING

PART I - GENERAL

1.1 REGULATORY REQUIREMENTS

- A. National Electrical Code Compliance: At a minimum, all grounding shall be in accordance with the National Electrical Code, Article 250.

PART 2 - PRODUCTS

2.1 GROUNDING

- A. ELECTRICAL EQUIPMENT: The metallic enclosures, equipment, metal raceways, and supports, etc., shall be bonded together to form a low-impedance ground-fault current path.
- B. Unit Substation Transformer Room Ground Bus: The Transformer Room Ground Bus shall be a copper bar, ¼" x 2", a minimum of 18" long, supported by 1" insulators, anchored to the wall. Anchors shall be installed a minimum of every 30". The Ground Bus shall be a Hargar GBI, or approved equal. All conductor terminations at the Ground Bus shall be by fittings UL Listed for grounding, such as Burndy YGA Series compression lugs, or approved equal. The Transformer Room Ground Bus shall be connected to all of the following Grounding Electrodes, when present.
 - A. Structural Steel
 - B. Underground Metal Water Pipe
 - C. Concrete Encased Electrode
 - D. Ground Rods
 - E. Ground Ring
- C. Structural Steel: A copper Grounding Electrode Conductor shall bond the building structural steel to the Transformer Room Ground Bus. The conductor shall be sized per NEC Table 250.66 as a minimum. Fittings for connection to the building steel shall be UL Listed for the purpose.
- D. Underground Metal Water Pipe: A copper Grounding Electrode Conductor shall bond the Transformer Room Ground Bus to the Water Main ahead of the meter, within 5' of entrance to the building. Connection to the water pipe shall be by means of a fitting UL listed for grounding, similar to a Burndy Model C-4, or approved equal. A similar sized bonding conductor shall be furnished across the water meter, using the same fittings. Bonding conductors shall be sized per NEC Table 250.66.
- E. Concrete Encased Electrode: Rebar in the building footings of 20' or more in length shall be bonded to the Transformer Room Ground Bus by a copper Grounding Electrode Conductor. Connection to the rebar shall be by fittings that are UL listed for the purpose. Burndy GAR series, or approved equal.
- F. Ground Rods: A grounding field shall be created with at least 2 copper ground rods. Rods shall be spaced at least 20 feet apart. Rods shall be copper clad steel, 10' long, ¾" diameter. Grounding triangle shall be bonded to the Transformer Room Ground Bus by a copper Grounding Electrode Conductor, sized per NEC or drawings, whichever is larger. Connection to the ground

rods shall be by fittings that are UL listed for the purpose. Connection to the rods shall be by exothermic welds, or fittings similar to a Burndy GP6429 or approved equal.

- G. Service Entrance Grounding: Bond the Transformer Room Ground Bus to the Ground Bus of the Unit Substation. All Ground bus within the Unit Substation sections shall be bonded together, including the Medium Voltage sections, transformer section, and secondary sections. The Grounded Conductor (Neutral) of the Substation secondary shall be bonded to the Ground Bus in the secondary section by a Main Bonding Jumper, sized per NEC.
- H. Distribution Transformers: All transformers shall have their secondary Grounded Conductor (Neutral) bonded to the building Transformer Room Ground Bus. If the transformers are located more than 100' from the Transformer Room Ground Bus, they can bond to the building structural steel, when present, instead of the Transformer Room Ground Bus.
- I. Lightning Protection Systems: Lightning Protection systems shall have their ground field bonded to the building grounding electrode system, per NEC requirements.

PART 3 - EXECUTION

All grounding work shall be done per manufacturer's instructions, and NEC requirements.

END OF SECTION 260526

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 260533 - RACEWAYS

PART I - GENERAL

1.1 UTILITY PLANT APPLICATION

- A. All wiring in Utility Plants shall be in rigid conduit; EMT conduit is not allowed.

PART 2 - PRODUCTS

2.1 RACEWAYS AND CONDUITS

A. General –

1. All raceways and conduits shall be installed with fittings, hangers, and accessories that are UL listed for their application.
2. All raceway installed for telecommunications low voltage shall conform to 27 00 00.
3. All conduits except flexible conduits shall be a minimum size of ¾”.
4. Per State of Illinois Law (30 ILCS 565/) Steel Products Procurement Act, all raceways, conduit, and fittings made of steel shall be manufactured in the United States of America.
5. Aluminum Conduits are not allowed without a written approval from Owners representative.
6. Metal Clad type MC cable is not allowed without written approval from Owners representative.

B. Electrical Metallic Tubing (EMT) shall be:

1. EMT shall be hot galvanized steel O.D. with a corrosion resistant I.D. coating, and shall be listed to UL Safety Standard 797 and manufactured in accordance with ANSI C80.3
2. Reamed after cutting
3. Installed above ceilings in joist spaces
4. Installed with steel, set screw type, couplings and connectors with insulated throats. As manufactured by Raco, T&B, OZ-Gedney, or approved equal. Die-cast or set-screw fittings are not allowed.
5. Installed in accordance with National Electrical Code Article 358 and the UL listing information.

C. Rigid Metal Wall Conduit (Rigid) shall be:

1. RIGID Metal Conduit shall be hot-dip galvanized steel. RIGID shall be produced in accordance with UL Safety Standard #6 and ANSI C80.1 and shall be listed by a nationally recognized testing laboratory
2. Installed in concrete slabs-on-grade and walls with 1-inch minimum concrete covering.
3. Installed in exposed exterior locations above grade.
4. Reamed after cutting threads. Threads shall be field-coated with Copper Anti-Seize Lubricant paste by Permatex, or equal.
5. Running threads are not allowed. A 3 piece coupling shall be used instead.

D. Flexible Metal Conduits shall be:

1. Flexible Metal Conduit type in all dry locations with steel, insulated throat, squeeze type connectors. Installed in accordance with the National Electrical Code Article 348 and the UL listing information
2. Liquidtight Flexible Metal Conduit type in all damp or wet locations, including all exterior locations, terminated with steel, insulated throat connectors. Installed in accordance with the National Electrical Code Article 350 and the UL listing information.
3. LFMC shall be used for the final connection to all motors, and FMC or LFMC shall be used for the final connection to vibrating equipment. Only FMC is allowed inside of plenums, including connections inside Air Handling equipment.
4. Used for the final connection to all recessed fixtures.
5. FMC or LFMC used as a lighting fixture whip or equipment whip shall be no longer than 6 feet.
6. FMC or LFMC shall not be used where a flexible connection is not necessary, or where raceway does not need to be "fished" into existing work. Using FMC or LFMC to avoid making bends in EMT or Rigid conduit is unacceptable.
7. All FMC or LFMC flexible conduits shall be a minimum size of 1/2". 3/8" FMC or LFMC shall only be allowed for luminaire whips or when factory installed on equipment.

E. PVC Conduits

1. PVC conduit may be used only in areas where corrosive conditions make use of steel raceways impractical.
2. PVC conduit may be used under sidewalks and driveways provided it is located 24 inches below concrete. If located less than 24 inches below concrete, PVC conduit shall be encased in concrete.

2.2 CONDUIT SUPPORTS AND HANGERS

A. General

1. All conduits shall be secured and supported in accordance with the appropriate NEC Article.
2. All straps and clamps shall be UL Listed for the conduit and application.
3. Supports for suspended conduits shall be threaded steel rods.

B. Surface Mounted Conduits

Use 1-hole straps with back-spacers, strut, or minerallac-type hangars

C. Suspended Conduits

1. Individual Conduits: Use minerallac galvanized conduit clamps with proper threaded rod.
2. Two or More Conduits adjacent to each other (trapeze hanger):
 - a. Use strut-type channel constructed from 12 gauge steel hung from at least 2 rods.
 - b. Use Listed galvanized strut clamps for Rigid and EMT conduits.

PART 3 - EXECUTION

3.1 METHODS OF WIRING

- A. Grounded Metallic Conduits: All of the conductors shall be run in grounded metallic conduits. Equipment and devices installed and not constructed with enclosures suited for mounting and enclosing all live parts, shall be installed in grounded metal cabinets.

- B. Grounded Metallic Raceways: It is intended that complete grounded metallic raceways or enclosures be provided for all circuiting throughout the extent of the systems specified.
- C. Concealed: All conduits shall be run to the distribution cabinets in a neat, accurate manner and shall be installed concealed in ceiling and wall construction where possible or exposed at right angles at roof purlin and beam locations as required.
- D. Hangers: Where conduits are to be run exposed, they shall be rigidly supported or secured in place by means of hangers suited to the conditions under which they are used.
- E. Clean Conduit: All conduits shall be swabbed until all moisture and grit is removed before any wires are pulled or installed.
- F. Wire Pulling Compound: Listed Pulling Compound may be used to ease the pulling of wire or cable. Excess compound must be removed.

3.2 RACEWAYS AND CONDUITS

- A. Metallic Conduit: All conductors shall be installed in metallic conduit.
- B. Conduit Size: All conduit shall be sized according to the National Electric Code except that minimum allowable size shall be 3/4-inch, except as otherwise noted above in this standard.
- C. Conduit identification— Conduits shall be color coded as follows:
 - 1. Fire alarm systems= Red
- D. Exposed Conduits: Shall be run parallel to and plumb with adjacent surfaces.
- E. Bends: All conduit bends shall be long radius.
- F. Open Ends Plugged: All open ends of conduits shall be plugged with approved raceway closures to prevent entrance of foreign material during construction - newspapers stuffed into boxes and/or conduits will not be allowed.
- G. Rigidly Supported: All conduits shall be rigidly supported to the building structure. No tie wiring will be allowed. (See paragraph entitled *Conduit Supports & Hangers*).
- H. Ends of Conduits: All ends of conduits shall butt solidly in couplings.
- I. Coordination: Coordinate all conduit locations with other trades before roughing-in.
- J. All conduits and raceways entering a building from underground shall be sealed around the conductors using Ideal Duct-Seal, or approved equal. Empty conduits shall be plugged.
- K. Insulated Inserts: Conduit bushings shall have insulated inserts where wire sizes are number 6 or larger.
- L. Four Extra Conduits: Four 1-inch conduits shall be installed from each flush mounted panel and turned into the joist space above the panel for future use.
- M. Underground Metal Conduit: Where metal conduit is in touch with earth, it shall be PVC coated conduit with factory applied UL listed PVC coating. Threads shall be field-coated with Copper Anti-Seize Lubricant paste by Permatex, or equal.
- N. Underground Conduit entering Buildings, Manholes, etc.: Where conduits enter a concrete wall in a building, manhole, etc., it shall be in Rigid conduit. The ductbank shall have rebar dowels drilled into the concrete wall to prevent shearing of ducts due to ground settling.
- O. Medium and High Voltage Distribution Conduit: All exposed indoor medium and high voltage distribution conduits shall be a minimum of 5" galvanized steel rigid metal conduit

- P. Primary Voltage Conduit: All outdoor underground conduits for primary voltage shall be a minimum of 5" PVC conduit concrete encased. Concrete shall have a minimum of two rebars the entire length.
- Q. 600V and below Service Entrance Conduit: All underground service entrance conduits shall be a minimum of 4" PVC conduit concrete encased.
- R. Medium and High Voltage Distribution Conduit: All indoor underground medium and high voltage distribution conduits shall be a minimum of 4" PVC conduit.

END OF SECTION 260533

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 260534 - LOW VOLTAGE RACEWAYS

PART I - GENERAL

1.1 SUMMARY

- A. The purpose of this Section is to set forth raceway requirements for permanently installed "low voltage circuits" in campus buildings. Compliance with this Section will promote reliability, improve aesthetics, minimize damage to buildings, and reduce maintenance expense and outages due to accidents and vandalism. This Section is not intended to cover technical aspects such as conductor sizing and terminations, nor is it intended to limit use of low voltage cords that have been manufactured specifically for use to and between pieces of equipment in a room.

1.2 DEFINITIONS

- A. In this Section, the term "low voltage circuits" includes all wiring not connected to a building power and lighting system, and includes wires, cables and circuits for communications, radio, television, telephone and similar systems.

PART 2 - PRODUCTS

2.1 NEW BUILDINGS

- A. NEC Compliance: All work shall be in compliance with applicable portions of the current National Electric Code regarding low voltage circuits.
- B. Concealed Raceways: All wiring shall be installed in metallic raceways, and in finished areas the raceways shall be concealed.
- C. Fire Stopping: Shall be accomplished by a UL listed system/assembly at each location where raceway or cable penetrates a fire rated barrier.

2.2 EXISTING BUILDINGS

- A. Fire Alarm and Emergency Lighting system changes and additions shall meet requirements for new buildings, with each system having its own metallic raceway system.
- B. Low Voltage Systems: For other low voltage systems and low voltage wiring in existing buildings, the National Electric Code shall be followed with the following exceptions:
 - 1. Existing Raceways: The first choice for installation of low voltage circuits for other than fire alarms and emergency lighting shall be to meet the requirements for new buildings. Existing raceways, except as indicated above, may be used where possible. Care shall be exercised to prevent disruption of existing systems when using common raceways.
 - 2. Finished Areas: Where it is difficult to use existing concealed raceways as described above, surface metallic or plastic raceways and boxes shall be installed. All holes through walls and floors shall have galvanized or plastic sleeves and shall be finished in a neat manner. Patching and refinishing shall match that of existing adjacent construction with regard to both material and appearance. Holes, sleeves and cables in exterior walls and foundations shall be permanently sealed on the outside to prevent entrance of water and insects. Surface raceways and boxes must be firmly and permanently attached to walls and ceilings by use of mechanical anchors. The use of adhesive backed tape is not permitted. Sleeves through floors shall extend at least 3/8 inches above the floor line and be sealed to prevent leaks to the floor below.
 - 3. Unfinished Areas, and above removable ceilings, raceways and boxes shall be provided for mechanical protection. Rigid conduit, EMT, IMC, surface metallic or plastic raceway and boxes may be used.

4. Raceways: EMT raceways shall be used in existing building interiors. Connectors shall be steel, compression, insulated throat.

2.3 SPECIAL CONSIDERATIONS:

- A. Fire Stopping: In compliance with the NEC, fire stopping shall be provided at each location where any raceway penetrates a fire rated barrier. Fire Stopping shall be accomplished by a UL Listed system/assembly.
- B. Airtight Seal: An airtight seal shall be provided to positively prevent airflow *within* any raceway that terminates at one end within a warmer environment and at the other end within a colder environment. This seal is needed to prevent condensation from occurring on electrical equipment within the colder environment. This requirement only applies to those raceways that are exposed to a "mechanism" or "driving force" to do one of the following.
 - a. Move airflow from the warmer to the colder environment due to differential air pressure such as in an air handling unit, air distribution plenum/housing or air distribution duct application.
 - b. Move humidity from the warmer to the colder environment due to differential water vapor pressure such as in a cold room application. This seal is needed to prevent condensation from occurring on electrical equipment/devices within the colder environment.

PART 3 - EXECUTION

3.1

END OF SECTION 260534

This section of the *UIS Facilities Standards* establishes minimum requirements only. It should not be used as a complete specification.

SECTION 260539 - BOXES

PART I - GENERAL

1.1 QUALITY ASSURANCE

- A. All boxes shall meet the requirements of the National Electric Code.
- B. All boxes shall be Underwriter's Laboratories listed.

PART 2 - PRODUCTS

2.1 FITTINGS AND BOXES – GENERAL

- A. All boxes shall be stamped, one piece, galvanized steel.
- B. All boxes shall be of the proper size and shape for conduits and the number of conductors entering them.
- C. All boxes shall be installed so that device and/or cover plates will be tight and plumb with wall finish.
- D. All unused conduit openings shall be closed with Knock-Out closures.
- E. All boxes shall be secured to building structure.
- F. Back to back boxes installed through the wall are not acceptable.

2.2 OUTLET BOXES FOR SURFACE MOUNTED FIXTURES SHALL BE:

- A. 4" octagonal or square as required, a minimum of 1-1/2" deep, furnished with fixture studs where required. .
- B. Boxes which support fixtures shall be supported from the structure. They shall not be supported by the suspended ceiling grid.
- C. Deep concrete boxes for poured concrete ceiling construction.
- D. Installed with plaster rings on suspended ceilings.
- E. 4" octagonal or square for all exposed conduit work with fixture extension pan or deep fixture canopy to enclose the box.

2.3 OUTLET BOXES FOR RECESSED FIXTURES SHALL BE:

- A. 4" square, a minimum of 1-1/2" deep, with blank cover.
- B. Installed in an accessible location.
- C. Installed with Flexible Metal Conduit from fixture outlet box to allow fixture to be dropped for servicing.

2.4 SWITCH AND RECEPTACLE BOXES SHALL BE:

- A. 4" square for up to 2 devices.
- B. Solid gang boxes for over 2 devices.
- C. Complete with tile ring where used in exposed tile, concrete block or paneled walls. Ring shall be sized so that face of ring is within 1/8" of surface of wall/tile.
- D. Complete with plaster ring where used in drywall and plastered walls. Ring shall be sized so that face of ring is within 1/8" of surface of wall.
- E. Installed with 1/2" raised galvanized device covers where used for exposed conduit work.

2.5 PULL BOXES AND JUNCTION BOXES SHALL BE:

- A. Installed in all runs of conduit having the equivalent of four 90 deg. bends.
- B. Installed in all runs of conduit more than 100 ft. in length.
- C. Sized per NEC 314.28 requirements
- D. #16 gauge galvanized steel up to 12" x 12" x 12" in size.
- E. #12 gauge galvanized steel over 12" x 12" x 12" in size.
- F. Entirely accessible.
- G. Complete with covers of same gauge as boxes and secured to boxes with screws.

PART 3 - EXECUTION

3.1 PROTECTION

- A. All conduits entering boxes shall be plugged or capped with approved raceway closures to prevent foreign material from entering conduits during construction. The use of newspaper stuffed into boxes will not be allowed.
- B. Label all individual conductors in each junction box.

END OF SECTION 260539

This section of the *U I S Facilities Standards* establishes minimum requirements only.
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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART I - GENERAL

1.1 EQUIPMENT IDENTIFICATION

- A. All equipment shall be labeled in the following format: "bbbb-eeee-ff", where:
1. "bbbb" is replaced with the building number corresponding with the equipment location.
 2. "eee" is replaced with the equipment abbreviation.
 3. "ff" is replaced with the floor it is on and panel designator if there is more than one panel of the same type.
- B. For example, if a distribution panel (DP) is located in building # 1240 on the first floor the correct labeling would be labeled 1240-DP1A427-21, with (letter designating 120/208 and number designating 277/480).
- C. Electrical equipment abbreviations shall be as follows:
1. Automatic Transfer Switch (ATS)
 2. Building Unit Substation (USS)
 3. Distribution Panel (DP)
 4. Emergency Distribution Panel (EDP)
 5. Emergency Lighting Panel (ELP)
 6. Emergency Power Panel (EPP)
 7. Emergency Receptacle Panel (ERP)
 8. Gen Set (G)
 9. Lighting Panel (LP)
 10. Photovoltaic Panels (PVP)
 11. Power Panel (PP)
 12. Receptacle Panel (RP)
 13. Transformer (T)
- D. Nameplates and Signs:
1. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch (2mm) minimum thick for signs up to 20 square inches (13 square cm), or 8 inches (200mm) in length; 1/8 inch (3mm) thick for larger sizes. Labels shall be punched for mechanical fasteners.
 2. Text Sizes:
 - (a) Text Height: 3/8 inch (10mm) minimum
 3. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.

4. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch (10mm) galvanized-steel backing; and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
 5. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
 6. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- E. Product Colors:
1. Adhesive Markings and Field Labels:
 - a. All Labels: Black letters on white face
 - b. Normal Power and General Labels: Black letters on white face.
 - c. Control Labels: Black letters on white face.
 - d. Medium Voltage (greater than 100 volts): Black letters on white face.
 - e. Fire Alarm: Red letters on white face .
 - f. Emergency: Red letters on white face.
 2. Nameplates and Signs:
 - a. NORMAL POWER: Black letters on white face
 - b. Control Labels: Black letters on white face
 - c. EMERGENCY: White letters on red face
 - d. GROUNDING: White letters on green face.
 - e. CAUTION or UPS: Black letters on yellow face
 3. Raceways and Conduit:
 - a. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
 - (a) Normal Power and General Distribution: Silver
 - (b) Emergency Power Distribution System:
 - (i) All Emergency: Orange
 - (ii) Legally Required Standby: Yellow
 - (iii) Optional Standby: Orange
 - (iv) Life Safety and Critical Branch: Yellow
 - (v) Equipment Branch: Orange
 - (c) Fire Alarm System: Red
 - (d) Temperature Controls: Blue
 - (e) Ground: Green
 - (f) Low Voltage and Telephone: Purple
 - (g) Clock, Sound, Security System, and Intercom: Black
 2. Box Covers:
 - a. Box covers shall be painted to correspond with system type as follows:
 - (a) Normal Power and General: Silver
 - (b) Emergency Power and Distribution:
 - (i) All Emergency: Orange

- (ii) Legally Required Standby: Yellow
- (iii) Optional Standby: Orange
- (iv) Life Safety and Critical Branch: Yellow
- (v) Equipment Branch: Orange

- (c) Fire Alarm System: Red
- (d) Temperature Controls: Blue
- (e) Ground: Green
- (f) Low Voltage and Telephone: Purple
- (g) Clock, Sound, Security System, and Intercom: Black

b. Box cover colors shall match conduit colors listed above.

F. Lighting Control and Receptacle Cover Plates:

1. Product:
 - a. Adhesive labels and field markings
 - b. Nameplates and signs
2. Identification material to be a clear, 3/8-inch (10mm) Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.
3. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. "C1A #24").

PART 2 - PRODUCTS

2.1

PART 3 - EXECUTION

3.1 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

A. Products:

1. Painted stencil 1" high lettering

B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, ups, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.

1. Interior Equipment: The identification material shall be painted stencil.
2. Exterior Equipment: The identification material shall be painted stencil.
3. Labeling shall include:
 - a. Equipment type and contract documents designation of equipment.
 - b. Voltage of the equipment.
 - c. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.

END OF SECTION 260553

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 260810 - ELECTRICAL SYSTEM START-UP

PART I - GENERAL

1.1 REFERENCES

- A. *NFPA 70 - National Electrical Code*
- B. *IEEE Standard 400-2012 - IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above*

1.2 SPECIAL CONDITIONS

- A. Independent Firm: All firms employed for testing shall be completely independent of the Project's Electrical Contractor.

1.3 MATERIALS

- A. Furnish All Materials: Furnish all personnel, meters, instruments, cable connections, equipment or apparatus for making all tests.

1.4 LOW VOLTAGE TESTING

- A. Test for Faults: After wires and cables are in place and connected to devices and equipment, the system shall be tested for short circuits, improper grounds, and other faults. When fault condition is present, the trouble shall be rectified, then retested.
- B. Within 2 Percent: Voltage test shall be made at each lighting and distribution panel. When potential is not within 2 percent of rated voltage, the condition shall be corrected by tap changes or power company correction of line voltage.
- C. Grounded or Shorted: All wiring devices and electrical apparatus furnished under this Contract, when grounded or shorted on any integral "live" part, shall be removed and the trouble rectified by replacing all defective parts and materials.
- D. Megger Test: All service and feeder cables, after being pulled in place and before being connected, shall have a Megger test conducted to determine that wire and cable insulation resistance is not less than that recommended by the National Electrical Code. Copies of all tests shall be given to the AE. All cables failing insulation test shall be removed, replaced, and retested.
- E. Motor Test: All motors shall be tested under load with a True RMS type meter. Readings shall be taken for each phase, and the rpm of motors recorded at the time. All motors shall be tested for correct direction of rotation. Run tests on all motors and verify that proper overload devices have been installed. Motors controlled by a Variable Frequency Drive shall be tested while running at full RPM. The following shall be submitted for approval by the AE. Test and record the following on all motors:
 - 1. Fuse size
 - 2. Heater size
 - 3. Full load amp
 - 4. Running amp
 - 5. Rated voltage
 - 6. Terminal operating voltage
- F. Copies: 2 copies of all test data shall be delivered to the Owner and AE.

1.5 HIGH VOLTAGE TESTING

- A. IEEE Standard 400-2012: On all new installations, cables shall be tested per IEEE Standard 400-2012. Maximum test voltages shall be in accordance with IEEE Standard 400-2012.
- B. Hi-Pot Test: When new cable is spliced to existing cables or tests are done on existing cables; a Facilities & Services electrical engineer shall be present and approve voltage levels for the High-Direct-Voltage (Hi-pot) test. IEEE Standard 400-2012 shall be used as a guideline except for the test voltage levels.
- C. Above 600 Volts: Cables above 600 volt and all associated terminations and splices installed shall be field tested in the presence of the AE and Owner personnel before being energized. All tests shall be in accordance with and under the direct supervision of an authorized, qualified representative of a certified testing company.
- D. Test Voltages: The maximum test potential shall be 25 KVDC for new cables only. The Owner shall specify the voltage for tests that involve existing high voltage cables. Test potentials shall be applied for 10 minutes. Allow 1 minute for voltage stabilization. Take 10 step readings at 2.5 KV increments. The following information shall be recorded:
 - 1. Leakage in microamps is to be recorded for each phase in increments starting at 1,000 volts going up to the maximum test voltage as specified in IEEE Standard 400-2012 or as specified by the Owner.
 - 2. Allow 1 minute for voltage stabilization between readings.
 - 3. After the maximum voltage is reached the leakage in microamps is to be recorded every minute for at least a minimum of 10 minutes.
- E. Graphs: In addition to the above recorded information, proper Graphs shall be plotted to show the following relationships:
 - 1. Leakage current in micro-amps versus time in minutes.
 - 2. Leakage current in micro-amps versus applied potential (KVDC).
- F. Identify Phase Conductors: Care shall be taken to properly identify the phase conductors tested in all test recordings and graph plots.
- G. Faults: If during the field acceptance testing a high resistance fault or low resistance fault in a component such as the cable, splice, or termination is apparent, the fault shall be cleared, necessary repairs made, and the cable retested in accordance with this specification.
- H. Moisture and Water: If the acceptance testing indicates a cable with possible moisture penetration, or water is observed in a cable, the cable shall be removed and replaced with new cable. The new cable shall be free of moisture and water.
- I. Replace Rejected Cable: If after proper testing of the cable the independent testing representative and/or the AE do not approve the cable, the cable that is not approved shall be removed and a new cable installed. All cables shall be tested and approved by the AE before final acceptance. Supply all additional cable that is required.
- J. Submittals: 3 copies of all acceptance test recordings and graphs shall be submitted to the AE before final acceptance of the distribution system will be authorized.

1.6 GROUND TESTING

- A. 25 Ohms Max: The resistance between ground grid and absolute earth shall not exceed 25 ohms and shall be measured in the presence of the AE before equipment is placed in operation. Testing shall be done per IEEE 81 – 2012 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System

1.7 FIRE ALARM AND DETECTION SYSTEM

A. See *Section 28 30 00 – Fire and Smoke Detection System* for Fire Alarm acceptance testing.

PART 2 - PRODUCTS

2.1

PART 3 - EXECUTION

3.1

END OF SECTION 260810

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 260923 - LIGHTING CONTROLS

PART I - GENERAL

1.1 DESIGN, SPECIFICATION, AND DOCUMENTATION

- A. *The goal shall be to reduce total life-cycle cost of the complete lighting system. The simplest control system shall be used which meets the project design requirements.*
- B. *Pay special attention to ensure compatibility of control voltages, ballasts, and control interface with other systems such as HVAC controls, daylighting sensors, window shades, etc. If a building-wide master lighting control system is used, it shall output lighting energy usage information to the Building Automation System (BAS).*
- C. *Documentation and user training are critical to successful use of lighting control systems. Include in bid documents the requirement for complete manufacturer as-built documents, O&M manuals, and a minimum of 16 hours training for building users and F&S maintenance personnel.*
- D. The location of all sensors, switches, user interfaces, relays, and load controllers shall be shown on the bid and construction document plans. Where there are multiple sensors, switches, or user interfaces in a room or space, the plans shall include labels, indexes, or other means to designate the light fixtures that are controlled by each device. Where sensors, switches, user interfaces of multiple types, ranges, or capacities are utilized on a project, the plans shall include labels, indexes, or other means to delineate the type, range, or capacity of each device. Where a specified sensor has a directionally specific sensing pattern, the intended orientation shall be indicated on the plans. The labeling, indexing or other means of indication shall clearly and unambiguously indicate the design intent.
- E. The bid and construction documents shall include wiring specifications and connection diagrams for the system that is the basis of design specific for each space. Typical diagrams for similar spaces shall be acceptable for spaces with similar devices and sequence of operations.
- F. The bid and construction documents shall include a specific sequence of operation indicated for each space with lighting controls. The plans shall include a label, index or other means of clearly and unambiguously indicating the intended sequence of operations for each space.
- G. Sequences of operations shall comply with the lighting control requirements of the Energy Code in force for the University at the time of bidding.

1.2 ENERGY CODE

For purposes of this section, the Energy Code in force for the University shall be the Illinois Energy Conservation Code's mandated Standards for State Funded Facilities as adopted and amended by the Capital Development Board including subsequent versions and amendments when adopted Capital Development Board.

PART 2 - PRODUCTS

2.1 EXTERIOR LIGHTING CONTROL

- A. Photocell with an adjustable on-off setting mounted on the roof of the building and a manual override test switch located in the building transformer room. The unit shall be mounted on 2-inch aluminum tubular stand, or other suitable manner, oriented to the north sky per manufacturer's specification. Provide the following in the transformer room:
 1. Hand-Off-Auto switch in pull box, wired in parallel with the photo-electric control and DDC control input for testing.

2. A street lighting contactor, 2-pole, with 120-volt, 60-cycle coil, actuated by the photo-electric control on roof. Size of the contactor shall be governed by the number of campus lighting fixtures controlled.
- B. In addition to the controls listed above, exterior lighting controls shall include the Exterior Lighting Control Requirements of the Energy Code in force for the University at the time of bidding.

2.2 INTERIOR LIGHTING CONTROL

- A. Interior lighting control systems shall consist of occupancy sensors, daylight sensors, switches and user interfaces, load and level controllers, output relays, interconnecting wiring, and associated accessories. The lighting control system shall be totally programmable via software interface and NO DIP switches or any other manual means of configuration. Hand-held remote devices used for configuration are not allowed.
- B. Provide lighting controls in each space as necessary to fulfill the project's program requirements for use of the space and the Energy Code's lighting control requirements for the space.
- C. Automatic lighting shutoff shall not be installed in electrical rooms, mechanical rooms, or elevator machine rooms. Automatic lighting shutoff shall not be installed in laboratories or workshops if automatic shutoff would endanger the safety or security of the room or building occupants. Automatic lighting shutoff shall not be installed in other spaces where automatic shutoff would endanger the safety or security of the room or building occupants. A list of all spaces being exempted from automatic lighting shutoff based on safety and security concerns shall be submitted and reviewed with the University during project design.
- D. Each controlled space shall include an isolated auxiliary relay contact for connection to the Building Automation System (BAS). The auxiliary contact can be, but does not have to be, integral to an occupancy sensor. The auxiliary relay shall indicate occupancy independent of the state of the lighting in the space (i.e. in an occupied room with the lights off, the auxiliary relay shall indicate occupied state to the BAS). Unless there is a specific design or operational reason for multiple auxiliary relay contacts, in a room or space with multiple occupancy sensors, there shall be one unique auxiliary relay that indicates if any of the occupancy sensors detect occupancy.
- E. Interior lighting control systems shall include occupancy based automatic receptacle control where needed to meet the requirements of the Energy Code. Except where necessitated by project program requirements, the occupancy sensor(s) installed in a space for lighting control shall also provide the automatic receptacle control.
- F. Interconnections between control devices shall be wired. Wireless sensors and control devices are not allowed.
- G. Systems that utilize programming to set or adjust device operation or function shall include programming software and programming interface devices. Systems that require proprietary programming devices shall include one of each required devices to the University for each project unless otherwise waived by the University. Software upgrades shall be included as ongoing manufacturer's support of the lighting control system.
- H. Switches and user interfaces shall be as simple as practical and include clear intuitive labels/markings indicating ON, OFF, RAISE, LOWER by text, symbols or both. Devices that require button sequences that are not discernable from the markings on the device are not acceptable.
- I. Occupancy sensors (auto on/off) and vacancy sensors (manual-on, auto-off) shall be used where appropriate.
 1. Occupancy sensors shall be dual-technology type unless specifically contradicted for the application.

2. Occupancy sensors subject to abuse (such as wall switch type) shall have tamper resistant housing.
 3. Occupancy sensors shall have clearly defined coverage patterns suitable for the application.
 4. Occupancy sensors with active automatically adaptive sensitivity and timer adjustments are not allowed.
- J. Daylight sensors shall be used where appropriate for daylight responsive lighting control.
1. Daylight sensors shall be solid state light level sensing units to automatically adjust the output of the controlled lighting fixtures.
 2. Daylight sensors shall control light fixtures directly or through associated load controllers
 3. Daylight sensors shall have adjustable sensitivity and output settings to tailor lighting control to the specific space and application.
 4. Daylight sensors shall have well defined coverage patterns and capacities suitable for application
- K. Load and level controllers
1. Load and level controllers shall have voltage and amperage ratings for the loads being controlled.
 2. Load and level controllers shall provide dimming and level signal and control fully compatible with the light loads being controlled.
 3. Load controllers for automatic receptacle control shall have a load rating of no less than 20 amperes at 120 volts.
 4. Load and level controllers shall be fully compatible with sensors, switches and user interfaces, load and level controllers, relays, and accessories.
 5. Where allowed by the Energy Code, daylight responsive lighting level adjustments shall be continuous in nature. Daylight responsive level adjustments of discrete, observable steps shall not be employed except where required by the application or conditions.
 6. Where daylight responsive lighting level control is provided in a space where lighting is also subject to manual adjustment of the general lighting level, the level controller shall be capable of responding to the manual level control in conjunction with the daylight sensor adjustments.
- L. Sensors, switches and user interfaces, load and level controllers, output relays, interconnecting wiring, and associated accessories utilized throughout the lighting control system shall be mutually compatible and function as an integrated system. All manual switches, controlled by Occupancy Sensors, shall be low voltage.
- M. System Wiring
1. Line voltage source and load wiring shall be individual conductors in conduit in accordance to sections 26 05 19 CONDUCTORS AND CABLE and 26 05 33 RACEWAYS of the UIS Facility Standards.
 2. Line voltage control wiring shall be individual conductors in conduit in accordance to sections 26 05 19 CONDUCTORS AND CABLE and 26 05 33 RACEWAYS of the UIS Facility Standards.
 3. Low voltage control wiring exposed and concealed in walls shall be conductors or cables in raceways in accordance to section 26 05 34 LOW VOLTAGE RACEWAYS of the UIS Facility Standards.
 4. Low voltage control wiring above accessible ceilings shall be conductors or cables in raceways in accordance to section 26 05 34 LOW VOLTAGE RACEWAYS of the UIS Facility

Standards or manufacturer specified multi conductor cables neatly installed and tied/attached to the conduit system serving the light fixtures controlled by the associated control system. Splices, taps, and terminations shall be enclosed in electrical boxes, device covers or device jacks that have no exposed contacts or live surfaces. Cables entering boxes or device enclosures shall be protected by grommets.

N. Auditorium and Lecture Hall systems

1. A system controlling multiple lighting zones and capable of storing and recalling multiple scenes shall be provided in Auditorium and Lecture halls where called for by the project's program requirements.
2. In addition to Energy Code requirements, the system shall include a Lecture/Presenter control station and scene control, and entrance control stations as appropriate.
3. The system shall include an interface for integration of the room's lighting control and scene selection with the room's instructional audio visual system. Coordinate requirements with UIS Technology Services. Provide a 3/4" conduit from the lighting system's interface module to AV equipment location.

O. Manufacturers:

1. Hubbell Control Solutions, Wattstopper, Leviton, Lutron, Acuity Brands/Sensor Switch.
2. For projects involving a partial portion of a building, consideration should be given to maintaining consistency of manufacturer with previously installed systems if present. Basis of Design should be based on manufacturer's system(s) already present in the building with other acceptable manufacturers listed as alternates as necessary to provide competitive bidding. If the existing system's manufacturer is not one listed above, consult F&S for approval of continued use.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturers Instruction: Install in accordance with manufacturers instruction.
- B. Verify Locations: Verify locations of switches, user interfaces and sensors before installation.
- C. Load and Level Controller Installation: In spaces with accessible ceilings, mount room controllers above ceiling as near to the main door to the space as practical. In spaces with inaccessible ceilings mount room controllers in accessible location near the room being controlled. In spaces with exposed ceilings, mount room controllers at ceiling as near the main door to the space as practical. Controllers in exposed locations shall be installed in junction boxes or suitable enclosures.
- D. Test and Adjust: After completion of installation, test and adjust control equipment and programming to function in accordance with project requirements, sequences of operations and the Energy Code.

3.2 COMMISSIONING

- A. Lighting control systems shall be in place, functional, and tested, prior to demonstration to the commissioning agent. Complete operational function shall be demonstrated to the commissioning agent prior to acceptance. A factory authorized representative shall be present during demonstration to provide adjustment and programming modifications as necessary.

3.3 TRAINING

- A. Upon completion of the work and after User acceptance of Functional Performance testing, on-site training shall be provided by an instructor thoroughly familiar with the installed system.

Training will be provided to the Owner's operating personnel who have responsibility for the lighting and control systems. The training shall focus on operation and maintenance of the installed system.

3.4 Personnel Factory training shall be provided for User- Maintenance Electricians.

END OF SECTION 260923

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 262213 - TRANSFORMERS

PART I - GENERAL

1.1 GENERAL

- A. For power distribution transformers requirements, see *Section 26 11 16 - Secondary Unit Substations*.
- B. Manufacturers: Eaton, Siemens, Square D, ABB Group, Cooper Industries.
- C. Location: Transformer, the Primary switch and the Secondary switch shall be located in an electrical room on the First floor, in new buildings, if possible; otherwise, an area well should be located by the basement electrical room. The area well shall be large enough to facilitate the delivery of the transformer to the electrical room.

PART 2 - PRODUCTS

2.1 INDOOR DRY TYPE TRANSFORMER (Primary over 600 Volts);

- a. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.
- b. Windings shall be copper.
- c. The cooling air temperature shall not exceed 40 degree C (104 degree F), and the average temperature of the cooling air for any 24-hour period shall not exceed 30 degrees C (86 degree F).
- d. The minimum ambient temperature shall not be lower than -30 degree C (22 degree F).
- e. The transformer shall be manufactured in accordance with UL standard "UL 1562".
- f. Transformer insulation shall be in accordance with 220 degree C UL insulation system.
- g. The transformer shall have an average temperature of 80 degree C, in a 40 degree C maximum, 30 degree C average ambient as defined by IEEE C57.12.01.
- h. Transformer shall be forced-air-cooled with fans installed in the transformer.
- i. Transformer shall have Four (4) 2.5% taps below rated, nominal voltage.
- j. Transformer impedance target shall be 5.75%.

2.3 INDOOR DRY TYPE TRANSFORMER (Primary under 600 Volts);

- a. Transformers shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.
- b. Windings shall be copper.
- c. The cooling air temperature shall not exceed 40 degree C (104 degree F), and the average temperature of the cooling air for any 24-hour period shall not exceed 30 degrees C (86 degree F).
- d. The minimum ambient temperature shall not be lower than -30 degree C (22 degree F).
- e. The transformer shall be manufactured in accordance with UL standard "UL 1562".
- f. Transformer insulation shall be in accordance with 220 degree C UL insulation system.
- g. The transformer shall have an average temperature of 150 degree C, in a 40 degree C maximum, 30 degree C average ambient as defined by IEEE C57.12.01.

- h. Transformer shall have two (2) 2.5% taps below rated, nominal voltage and two (2) 2.5% taps above rated, nominal voltage.
- i. Transformer impedance target shall be per manufacturers recommendation.

2.4 INDOOR LIQUID-FILLED TYPE TRANSFORMER (Primary over 600 Volts);

- a. Sound Level; Sound level of transformer without fans shall be a minimum of 3 db less than NEMA TR-1 standard sound levels.
- b. Insulating Liquid: Less flammable, biodegradable and nontoxic.
- c. Insulation Temperature Rise: 65 degree C, based on an average ambient temperature of 30 degree C, over 24 hours with a maximum ambient temperature of 40 degree C.
- d. Taps: Full voltage taps of four (4) nominal 2.5% taps, 2 above and 2 below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- e. Cooling System; Class self-cooled.
- f. Removable radiators.
- g. Impedance: 5.75%
- h. Accessories: Liquid-level gage, pressure-vacuum gage, liquid temperature indicator, drain and filter valves, and pressure relief device.

PART 3 - EXECUTION

3.1

END OF SECTION 262213

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 262300 - LOW VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 Manufacturers: Eaton, Siemens, ABB or Square D.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

- A. All phase, Neutral, and ground busses shall be tinned copper.
- B. Switchgear shall be Fully Rated. No series rating allowed.
- C. Switchgear shall have sufficient Short-Circuit Current Rating for the available Fault Current.

2.2 FUSIBLE MAIN SECONDARY SWITCH

- A. Over 601 Amps: Switches over 601 amps shall be quick-make, quick-break, bolted pressure switches equal to Barkelew "Bolt-Loc" pressure contact. Switch shall be complete with UL Class "L" Time-Delay fuses with 200,000 ampere interrupting capacity.
- B. Under 601 Amps: Switches under 601 amps shall be molded case circuit breakers or fused switches with either UL Class L, RK-1, or J fuses, where the interrupting capacity of the device is greater than that of the transformer feed.

2.3 FEEDER CIRCUIT BREAKER DEVICES

- A. Type: Feeder circuit breakers shall be manually or electrically (as required) operated, draw-out type or molded case, in the proper pole arrangement, and possess current ratings and interrupting capacity.
- B. Short Circuit Current: All electrical equipment such as sub-stations, bus-duct, panelboards and motor control centers shall be constructed to withstand the short circuit current, symmetrical and asymmetrical, for the number of cycles as required by the rating of the particular overcurrent protective device.
- C. Auxiliary Loads: Campus lights, steam tunnel lights, pumps, outdoor tennis courts, or an adjacent building may be supplied with power from the secondary switchgear of the building. Branch circuit overcurrent device, especially for these subsidiary loads, shall be a part of the secondary switchgear in the room.

PART 3 - EXECUTION

3.1

END OF SECTION 262300

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 CONSTRUCTION

- A. ALL PHASE, NEUTRAL, AND GROUND BUSES SHALL BE TINNED COPPER.
- B. SWITCHBOARDS SHALL BE FULLY RATED. NO SERIES RATING ALLOWED.
- C. SWITCHBOARDS SHALL HAVE SUFFICIENT SHORT-CIRCUIT CURRENT RATING FOR THE AVAILABLE FAULT CURRENT.

PART 2 - PRODUCTS

2.1 FUSIBLE MAIN SECONDARY SWITCH UNIT(S)

- A. Secondary Switch Units: When required, shall be quick-make, quick-break, bolted pressure switches. Switches shall be complete with UL Class "L" Time-Delay fuses with 200,000 ampere interrupting capacity.

2.2 FUSIBLE FEEDER SWITCH DEVICES

- A. Larger Than 600 Amps: Main switches larger than 600 amperes shall be quick make, quick break, bolted pressure switches with NEMA Class "L" fuses.
- B. 200,000 Ampere Interrupting Capacity: Fuses for all switches shall be UL listed, current limiting, time delay, silver link, fuses with 200,000 ampere interrupting capacity. Dual element fuses shall be self-protecting from extraneous heat.
- C. All fuses 600 volts or less shall be manufactured by Bussmann, Mersen, or Littlefuse..
- D. Feeder Circuit Breaker
 - 1. Shall be manually or electrically (as required) operated draw-out type or molded case, in the proper pole arrangement, and possess current ratings and interrupting capacity.
 - 2. All electrical equipment such as sub-stations, bus-duct, panelboards, switchboards and motor control centers shall be constructed to withstand the short circuit current, symmetrical and asymmetrical, for the number of cycles as required by the rating of the particular overcurrent protective device.
 - 3. Campus lights, steam tunnel lights, pumps, outdoor tennis courts, or an adjacent building may be supplied with power from the secondary switchgear or switchboard of the building. Branch circuit overcurrent device, especially for these subsidiary loads, shall be a part of the secondary switchgear or switchboard in the room.
- E. Manufacturers: Eaton, Siemens, ABB or Square D.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Labels: All conductors at the main secondary protective device shall be clearly identified with 1-inch high stencil letters with orange-colored paint.

3.2 QUALITY CONTROL

- A. Testing Secondary Voltages: After installation, the switchboard unit sub-station shall be energized for test and the secondary voltages checked for phase rotation between phases, and between each phase and neutral before the main secondary overcurrent protective device is closed.

END OF SECTION 262413

This section of the *U I S Facilities Standards* establishes minimum requirements only.
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SECTION 262416 - PANELBOARDS

PART I - GENERAL

1.1 SECTION INCLUDES

- A. This section applies to branch circuit and distribution panels.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Breakers for Devices 400 Amps or Less: Protective devices in branch circuit and distribution panels that are rated 400 amperes or less shall be circuit breakers with appropriate short circuit ratings to maintain building coordination. Circuit breakers shall have bolt or screw mounting to bus. Push-on mounting to bus is unacceptable.
- B. All panelboards shall be FULLY RATED. No Series-Rating is allowed.
- C. Lighting and Receptacle Breakers: Branch circuit breakers for lighting and convenience receptacles shall be 20 amperes. Lighting and receptacles shall be connected to separate circuits. Lighting fixtures shall be fed from Lighting Panelboards. Receptacles and power shall be fed from Receptacle Panelboards or Power Panelboards. All lighting and receptacle branch circuits shall be fed from the same floor lighting or receptacle panelboards.
- D. Emergency Panel boards: When necessary for NEC Selective Coordination requirements, Emergency Panel boards can be fusible type, similar to Eaton Busman QSCP, or approved equal.
- E. Panel Capacity: All new distribution and branch circuit panels shall have 42 spaces. In addition, all new panels shall have a minimum of 9 spare spaces when installation is complete. Panel boards with 84 circuits in one panel are not allowed. Panel boards with 42 circuits and feed-thru lugs to a panel board next to it for a total of 84 circuits are allowed.
- F. Gutter Space: New branch circuit panels shall have minimum of 5-inch gutters, with additional gutter space being provided for feeder lugs or main breaker as required for particular installations.
- G. Lockable: All distribution and branch circuit panels shall be lockable. Panels with interiors and trims that do not allow use of this lock are unacceptable. Panel boards shall be door-in-door type.
- H. Schedule: Each panel shall contain a typewritten schedule. The schedule shall contain complete and detailed information for loads on each circuit. Any changes, additions, or modifications to Panel boards shall require in a new typed directory.
- I. Buss Material: All panelboard Phase, Neutral, and Equipment Ground buss shall be copper.
- J. Fire Equipment Breakers: All breakers supplying equipment associated with the Fire Alarm System shall be red in color, Per NEC Article 760. Breaker shall be factory colored red – painting in the field is not allowed.
- K. All Panelboards enclosure shall be door-in-door type.
- L. Manufacturers: Eaton, ABB, Siemens or Square D.

2.2 ARC-FLASH LABELING

- A. All Panel boards shall have arc flash warning labels on the electrical equipment with a specific incident energy value in calories/cm².
 - 1. Perform incident energy calculations (arc flash analysis) by a qualified engineer using methods similar to those described in IEEE Standard 1584-2002 "Standard Method for Determining Incident Energy" - Nov 2002
 - 2. Incident Energy calculations take into account bolted fault current, clearing time, equipment type, grounding and construction over a range of voltages
 - 3. Information required to perform an Arc-Flash Analysis shall include:
 - a. Up to date system one-line diagram (NFPA 70E)
 - b. Conductor size, types, and lengths
 - c. Electric utility source information
 - d. Current short-circuit/coordination study (*per 2.5*)
 - e. Validated protective device types and settings
- B. Arc-Flash labels shall meet the requirements of NFPA 70E.
 - 1. Labels shall include the following information for Appropriate PPE Required:
 - a. Flash Hazard Boundary Distance
 - b. Flash Hazard at 18 inches
 - c. Arc-Flash Hazard Risk/PPE Category
 - d. Shock Hazard when cover is removed
 - e. Class of glove
 - f. Limited Approach Distance
 - g. Restricted Approach Distance
 - h. Prohibited Approach Distance
 - i. Name. Address of Company preparing the Label
 - j. Date of Label Preparation

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Flush Mounted: Where possible, distribution and branch circuit panels installed in finished areas shall be flush mounted and served through concealed conduit.
- B. 65 Feet Max Distance: Branch circuit panels shall be located so that they will be not more than 65 feet from any portion of the floor served, so that branch circuits will not exceed 100 feet in total length.
- C. 4 Spare Conduits: All flush mounted panels shall have at least 4 spare 3/4-inch conduits extended to space above or near the ceiling for future use.

END OF SECTION 262416

This section of the *U / S Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

- A. All devices and materials shall be Underwriter's Laboratories, (UL) listed.
- B. All devices, switches, receptacles, and cover plates shall be specification grade.

PART 2 - PRODUCTS

2.1 WIRING DEVICES

- A. Switches: Switches shall be composition body, flush tumbler, quiet type, side wired, toggle handle. Switches rated for 120 or 277 volts, A.C., shall be rated 20 amperes.
- B. Receptacles: Receptacles shall be duplex, single, or as scheduled in Contract Documents, flush, straight blade, or grounding type. Duplex receptacles shall be NEMA-520R. Receptacles in damp or wet locations shall be Listed as "weatherproof". Receptacles shall be Listed as "tamperproof" in locations required by the NEC.
- C. GFCI receptacles shall be the self-testing type.
- D. Receptacle Color: The color of devices shall be brown or ivory. Emergency powered receptacles shall be red. All controlled receptacles shall be colored "GREEN" and factory marked with NEC control symbol per Article 406.
- E. Cover Plates, Finished Areas: Interior cover plates in finished offices, classrooms, and other general purpose occupancies shall be #430 brushed stainless steel. Interior cover plates in laboratories and other potentially corrosive occupancies shall be #302/304 brushed stainless steel.
- F. Cover Plates, Unfinished Areas: Interior cover plates in unfinished areas shall be stamped galvanized for sheet metal boxes and cast for cast boxes.
- G. Outdoor Cover Plates: All outdoor receptacle covers noted as "weatherproof" or installed outdoors shall remain rain-tight whether or not a plug and cord is inserted. Covers shall be sunlight resistant, pad lockable, polycarbonate construction.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. 6 Per Circuit: The number of 120 volt convenience receptacles shall not exceed 6 per circuit, with the number being less than 6 per circuit where heavy loading is expected, or when dedicated special purpose receptacles are necessary.
- B. Distance from Jamb: Lighting switches shall be located 6 inches horizontally from doorjamb.
- C. Ganged Switches: Switches shall be ganged when they are together at 1 location.
- D. GFI Protected: Receptacles in all toilet rooms, bathrooms, janitor's rooms, potentially wet or damp areas, or other locations required by the NEC shall be ground fault circuit interrupter protected.
- E. HP Rated: Switches controlling or disconnecting motor loads shall be horsepower (HP) rated.
- F. Switch Position: Install all wall switches with OFF position down.
- G. Grounding Pole Position: Install receptacles with grounding pole on bottom for vertically mounted receptacles, and on the right for horizontally mounted receptacles.
- H. Flush and Level: Cover plates shall be installed flush and level.

- I. Labels: Receptacle cover plates shall be labeled with the panelboard and circuit designation when requested by the department occupying the finished space. This requirement shall be defined during the Project's design phase.
- J. Surge Arrestor Receptacles: High quality, high sensitivity, surge arrestor receptacles shall be required in areas that serve personal computers or other sensitive electronic equipment when requested by the department occupying the finished space. This requirement shall be defined during the Project's design phase. All overhead projectors shall have surge arrestor receptacle.
- K. Receptacle Grounding:
 - 1. Receptacles shall have ground terminals bonded to the conduit system, except in the case of isolated ground receptacles. Isolated ground receptacles shall require a separately routed ground conductor.
 - 2. Receptacles shall have a green ground wire bonded to the device grounding terminal, the box it is located in, and bonded to the branch circuit panelboard ground bus.
- L. Do not install back-to-back in the same wall.
- M. Provide insulation behind boxes mounted in exterior walls

END OF SECTION 262726

This section of the *U I S Facilities Standards* establishes minimum requirements only.
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SECTION 262813 - FUSES

PART I - GENERAL

1.1 SUBMITTALS

- A. The electrical contractor shall furnish and install a complete set of fuses for all fusible equipment on the job as specified by the electrical drawings. Final tests and inspections shall be made prior to energizing the equipment.
- B. All fuses shall be by Bussmann, Mersen, or Littlefuse.

PART 2 - PRODUCTS

2.1 Fuses shall be as follows:

- A. Mains, Feeders and Branch Circuits
 1. Circuits 601 to 6000 amperes shall be protected by current-limiting Class L fuses. Fuses shall be time-delay and shall hold 500% of rated current for a minimum of 4 seconds, clear 20 times rated current in .01 second or less and be UL Listed and CSA Certified with an interrupting rating of 200,000 amperes RMS symmetrical. Mersen A4BQ, Bussmann KRP-C, or Littlefuse KLPC series.
 2. Circuits 600 amperes or less shall be protected by current-limiting Class RK1 time-delay, or Class J time-delay fuses. Fuses shall hold 500% of rated current for a minimum of 10 seconds (30A, 250V Class RK1 case size shall be a minimum of 8 seconds) and shall be UL Listed and CSA Certified with an interrupting rating of 200,000 amperes RMS symmetrical. Mersen A2D/A6D or AJT, Bussmann LPN/LPS or LPJ, Littlefuse LLNRK/LLSRK or JTD
- B. Motor and Motor Controller Protection
 1. All individual motor circuits shall be protected by Class RK1, Class J or Class L time-delay fuses as follows:
 - a. Circuits up to 480A: Class RK1, or Class J
 - b. Circuits over 480A: Class L
 2. Fuses shall be chosen in accordance with motor control manufacturers' published recommendations, based on Type 2 test results. As a general rule, fuses shall not exceed 125% of the value in NEC Table 430.248 or 430.250
- C. Variable Frequency Drive Protection
 1. All Variable Frequency Drives shall have their inputs protected by high-speed fuses, such as Bussmann FWH series, or approved equal, or other fuse model as required by the manufacturer. Always consult manufacturer instructions to ensure correct protection.
Spares

2.2 Spare Fuses

- A. Spare fuses amounting three of each type and rating shall be supplied by the electrical contractor. These shall be turned over to the owner upon project completion.
- B. Fuses shall be contained and cataloged within the appropriate number of spare fuse cabinets (no less than one). Spare fuse cabinets shall be equipped with a key lock handle, be dedicated for storage of spare fuses and shall be by Mersen, Busmann, or Littlefuse.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

- A. Fuses shall not be installed until equipment is to be energized. All fuses shall be of the same manufacturer to assure selective coordination.
- B. Final tests and inspections shall be made prior to energizing the equipment. This shall include a thorough cleaning, tightening, and review of all electrical connections and inspection of all grounding conductors.

3.2 SUBMITTALS

- A. As-built drawings shall be submitted to the engineer after completion of the job.

END OF SECTION 262813

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 262816 - DISCONNECT SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Disconnect switches, safety switches, elevator shunt trip disconnect switches.

1.2 REFERENCES

- A. Switches shall be manufactured in accordance with the following standards:
 1. UL 98 - Enclosed and Dead Front Switches
 2. NEMA KS 1 - Enclosed Switches
 3. NEMA 250 - Enclosures for Electrical Equipment

1.3 SERVICE ENTRANCE

- A. Switches identified for use as service equipment are to be labeled for this application.

1.4 SUBMITTALS

- A. Provide outline drawings with dimensions, and equipment ratings for voltage, amperage, horsepower and short circuit.
- B. Submit listing of all types, sizes and quantity of fuses which will be installed including the location of each.
- C. Elevator shunt trip disconnect switches shall be submitted with all applicable options selected. Include wiring diagrams for controls.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Safety Switches shall be manufactured by Square D, Eaton, Siemens or ABB.
- B. Elevator shunt trip switches shall be manufactured by Cooper Bussmann, Eaton, or Littelfuse.

2.2 DISCONNECT SWITCHES FOR MOTORS AND GENERAL USE

A. SWITCH INTERIOR

1. All switches shall have switch blades which are visible when the switch is OFF and the cover is open. [Type 1, 3R, 4-4X-5 stainless steel, 4X polyester, 12, 12K].
2. Lugs shall Listed for 75° C.
3. Switches required for Type 12, 12K or Type 4-4X-5 stainless steel applications shall have all copper current carrying parts.

4. All current carrying parts shall be plated to resist corrosion.
5. Switches shall have removable arc suppressors to facilitate easy access to line side lugs.
6. Switches shall have provisions for a field installable electrical interlock.
7. When a Safety Switch is installed between a VFD and the motor, it shall contain an Auxiliary Contact. The Aux Contact shall be wired into the VFD safety Circuit to shut the VFD off before the switch opens, and not allow it to start before the Safety Switch is closed.

B. SWITCH MECHANISM

1. Switch operating mechanism shall be quick-make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started.
2. The operating handle shall be an integral part of the box, not the cover, [Type 1, 3R, 4-4X-5 stainless steel 4X polyester, 12, 12K]
3. Provisions for padlocking the switch in the OFF position with at least three padlocks shall be provided.
4. The handle position shall travel at least 90° between OFF and ON positions to clearly distinguish and indicate handle position, [Type 1, 3R, 4-4X-5 stainless steel, 4X polyester, 12, 12K].
5. All switches [Type 1, 3R, 4-4X-5 stainless steel, 4X polyester, 12, 12K] shall have a dual cover interlock mechanism to prevent unintentional opening of the switch cover when the switch is ON and prevent turning the switch ON when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

C. SWITCH ENCLOSURES

1. The enclosure shall be finished with [gray baked enamel paint which is electrodeposited on cleaned, phosphate pre-treated steel (Type 1)], [gray baked enamel paint which is electrodeposited on cleaned, phosphate pre-treated galvanized steel (Type 3R, 12, 12K)], [A brush finish on type 304 stainless steel (Type 4-4X-5 stainless steel)], [Gray baked enamel on copper free cast aluminum alloy (Type 7/9)].
2. The enclosure shall have ON and OFF markings [stamped into the cover (Type 1, 3R, 4-4X-5 stainless steel, 12, 12K)], [Cast into the cover (Type 7/9)], [Inked on a adhesive label (Type 4X polyester)]
3. All switches shall have provisions to accept up to three 3/8 in hasp padlocks to lock the operating handle in the OFF position.
4. Tangential knockouts shall be provided to facilitate ease of conduit entry [Type 1, 3R, 12K] for switches rated 30-200A.

- D. Type 12 and 4-4X-5 stainless steel enclosure shall contain no knockouts. Supply watertight hubs as indicated on the plans.

- E. Type 4X polyester enclosures shall be provided with polyester conduit hubs for field installation.
- F. Type 7/9 enclosures shall be provided with threaded conduit openings in both end walls.
- G. Enclosures for Type 3R switches through 200 ampere shall have provisions for interchangeable bolt-on hubs in the top end wall. Hubs shall be sized as indicated on the plans.
- H. Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor applications.
- I. Type 12, 4-4X-5 stainless steel enclosures shall be dual rated as Type 3R to facilitate their use in outdoor applications.

J. SWITCH RATINGS

- 1. Switches shall be horsepower rated for AC and/or DC as indicated on the plans.
- 2. Switches shall be rated "Heavy Duty" except when used as required as primary disconnecting means for DDC control panel power conditioners.
- 3. The UL Listed short circuit current rating of the switches shall be 200,000 rms symmetrical amperes.

K. ELEVATOR SHUNT TRIP DISCONNECT

- 1. Provide shunt trip disconnect switch in a single NEMA enclosure with all necessary relay(s), control transformer and other options (as listed below), and as shown on drawings. The disconnect switch shall be constructed, listed and certified to the standards as listed above. The disconnect switch shall have an ampere rating as shown on the Contract Drawings, and shall include a horsepower rated fusible switch with shunt trip capabilities. The amp rating of the switch shall be based upon elevator manufacturer requirements and utilize Class J Fuses (provided separately). It shall include as an accessory, a 100VA control power transformer with primary and secondary fuses. The primary voltage rating shall equal line voltage, with a 120V secondary. It shall also contain an isolation relay (3PDT, 10 amp, 120V). The coil of the isolation relay shall be 120Vac. A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid (140VA inrush at 120V).
- 2. The shunt trip disconnect switch shall contain the following options:
 - a. Key to Test Switch
 - b. "ON" Pilot Light (Green)
 - c. 1P NC Mechanically Interlocked Auxiliary Contact (required for hydraulic elevators with automatic recall)
 - d. Fire alarm voltage monitoring relay (needed to comply with NFPA 72)
 - e. Auxiliary contacts, allowing disconnect switch to be turned off for maintenance without sending a supervisory or trouble signal to the fire alarm control panel.

- f. 120Vac option shall be selected for fire alarm interface relay.
- g. NEMA 1 enclosure

PART 3 - EXECUTION

END OF SECTION 262816

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 262913 - MOTOR CONTROL

PART I - GENERAL

1.1

PART 2 - PRODUCTS

2.1 MOTOR STARTERS

- A. Magnetic Type: Starters for motors shall be of the Combination Starter/Fused Disconnect, magnetic type as required for the respective motor service, complete with overload protection, in all 3 phases.
- B. NEMA Design: Starters and electrical components shall be of the NEMA design. IEC type shall not be allowed. NEMA size 1 starter shall be the minimum size allowed.
- C. Combination Starter / Fused Disconnect Switch Units: Shall be installed in either motor control centers or individual enclosures provided for each motor.
- D. Motor starter coils and control circuits shall be powered by a 120 volt control transformer located within the motor starter enclosure.
- E. Combination Starter/Fused Disconnect Switch Unit: Shall incorporate the following:
 - 1. NEMA Fused Disconnect Switch: A fused disconnect switch of the NEMA design, as opposed to the IEC type. Disconnect switch shall be NEMA type HD and shall be UL listed. Time delay Class RK1 fuses shall be used. Maximum fuse size shall be 130% of motor full-load amperes.
 - 2. Magnetic Starter: A magnetic starter of the NEMA design, as opposed to the IEC type.
 - 3. Overload Relay: Overloads shall be of the Solid State Electronic type. Relay shall include Phase-Loss protection. Relay shall be able to provide Class 10 and Class 20 overload protection. Relay shall be set to match motor full load amperage from nameplate.
 - 4. Control Transformer: Motor starter coils and control circuits shall be powered by a 120 volt control transformer located within the motor starter enclosure. Primary and secondary fusing shall be provided.
 - 5. Hand-Off-Auto Switch: A NEMA design oil tight cover mounted hand-off-auto switch.
 - 6. Auxiliary Contact Kit: An auxiliary contact kit with one NO and one NC sets of contacts.
 - 7. Pilot Light: A NEMA design oil tight cover mounted 120 V pilot light, with "RED" lens for "Run" status indication, and "GREEN" lens for "Stop" status indication. Pilot light shall be LED, push-to-test. Incandescent 120V pilot light type is not allowed.
- F. Starter Selection: Shall be based on the following table for particular installations:

If the motors are fed from the same transformer that supplies the building lighting and receptacle loads, then the inrush KVA shall not exceed 20 percent of the transformer KVA rating. Inrush KVA shall be computed using the mid-range value of the code letter designation of the motor. A table showing the maximum horsepower permitted for different size transformers based on

motors with a code letter "G" has been supplied as a sample.

Code "G" has a mid-range value of 6 KVA per horsepower.

<u>KVA of Transformer</u>	<u>Maximum Across- the-Line HP</u>
100	5
225	7-1/2
300	10
500	5
750	25
1000	30

G. Reduced Voltage Starters: For motors over 50HP, provide Variable Speed Drives. . For variable frequency drive applications see Section 26-29-23.

H. Manufacturers

1. Eaton
2. Siemens
3. ABB
4. Square D

PART 3 - EXECUTION

3.1

END OF SECTION 262913

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 262923 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED UIS STANDARDS

- A. Section 260519 – Conductors and Cables: VFD Cable
- B. Section 260553 – Identification of Electrical Systems
- C. Section 266000 – Common Motor Requirements

1.2 REFERENCES

- A. ANSI/UL Standard 508
- B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- C. IEEE Standard 519-1992 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- D. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00.
- B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- C. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- E. Provide harmonic distortion analysis of total service to prove variable frequency drives proposed do not exceed the latest version of IEEE 519 voltage and current distortion limits as shown in Table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 26 05 00.
- B. Accept controllers on site in original packing. Inspect for damage.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.
- C. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- D. Shop Drawings: For each VFD.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. UL listing for series rating of overcurrent protective devices in combination controllers.
 - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. VFD and enclosure:
 - 1. Toshiba
 - 2. ABB Inc.
 - 3. Danfoss

2.2 DESCRIPTION

- A. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The controller shall be suitable for use with standard NEMA B squirrel cage 1.15 service factor induction motors without requiring any modifications to the motor or the drive.
- B. Controller shall have sufficient capacity to provide speed control of the motors shown or noted throughout the specified environmental operating conditions.
- C. Controller shall have the functional components listed below:
 - 1. Door interlocked input circuit breaker/fused switch.
 - 2. Input rectifier section to supply fixed DC bus voltage.

3. Smoothing reactor for DC bus.
4. DC bus capacitors.
5. Control transformer.
6. Separate terminal blocks for power and control wiring.
7. Terminal block for operator controls.
8. Sine weighted PWM generating inverter section.

2.3 RATINGS

- A. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
- B. Operating Ambient: 0°C to 40°C.
- C. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
- D. Minimum Elevation without Derating: 3300 feet.
- E. Minimum Efficiency at Full Load: 96 percent.
- F. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds or 180% for 0.5 seconds.
- G. Starting Torque: 100 percent of rated torque or as indicated.
- H. Speed Regulation: Plus or minus 1 percent with no motor derating.

2.4 DESIGN

- A. Pulse Width Modulated (PWM) Variable Frequency Drives:
 1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section.
 2. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz. If derating of the inverter is necessary to run at 8kHz, then the unit's derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.
 3. All controllers supplied with semi-conductors capable of switching at less than 8,000 Hertz shall be supplied with a motor acoustic noise reduction filter.
 4. Pulse width modulated (PWM) drives shall be supplied with drive input line reactors with a minimum impedance of 3%. Reactors shall be installed to filter entire drive input circuit.
 5. Pulse width modulated (PWM) drives shall be supplied with drive input harmonic filter to reduce the total harmonic distortion to less than the IEEE519-1992 limits at the utility service entrance.
 6. Drives that are located beyond the manufacturer's recommended maximum distance from the motor shall be provided with dV/dt (long lead) filters.

- B. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.
- C. Drive shall restart after power loss and under-voltage fault. The minimum number of restart attempts required shall be three, field adjustable.
- D. The drive shall allow unlimited switching of the output without damage to the drive or motor.

2.5 PRODUCT FEATURES

- A. Display: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current).
- B. Protection:
 - 1. Input transient protection by means of surge suppressors.
 - 2. Snubber networks to protect against malfunctions due to system transients,
 - 3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 - 4. Motor thermal overload relay(s) adjustable and capable of NEMA Class 10 or 20 motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.
 - 5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 - 6. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.
 - 7. Loss-of-phase protection.
 - 8. Reverse-phase protection.
 - 9. Short-circuit protection (fuses or circuit breaker).
 - 10. Motor overtemperature fault.
- C. Acceleration Rate Adjustment: 0.5 - 30 seconds.
- D. Deceleration Rate Adjustment: 1 - 30 seconds.
- E. Minimum Adjustment Range for the Lower Output Frequency shall be: 0 to 40 Hertz.
- F. Minimum Adjustment Range for the Upper Output Frequency Range shall be: 40 to 90 Hertz.
- G. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.
- H. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.

- I. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.
- J. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.
- K. Provide adjustable skip frequencies on the drive output (minimum of three ranges).
- L. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- M. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- Q. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).
 - 3. Motor status (running, stop, fault).
 - 4. Motor current (amperes).
 - 5. Motor torque (percent).
 - 6. Fault or alarming status (code).
 - 7. PID feedback signal (percent).
 - 8. DC-link voltage (VDC).
 - 9. Set-point frequency (Hz).
 - 10. Motor output voltage (V).
- S. Control Signal Interface:
 - 1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 - 2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).

3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
4. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).
5. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- T. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 23 09 00. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.
- U. Control:
 1. With the "Manual-Off-Auto" switch in the "Manual" position the drive shall be controlled by the manual speed potentiometer on the drive door.
 2. With the "Manual-Off-Auto" switch in the "Auto" position the drive shall be controlled by the input signal from an external source.
 3. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.
 4. If applicable, signal from the fire alarm control panel shall shut down VFD.
 5. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.

2.6 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. All VFD supplied for fans shall have dynamic or DC injection braking capability to provide a means of rapid deceleration of the AC motor in not more than one (1) minute. Adjust controls to stop the motor within 30 seconds.
- C. All high inertia loads that cannot be stopped in 30 seconds with the VFD dynamic braking or DC injection braking shall be provided with a chopper module and dynamic braking resistor to stop the motor within 30 seconds.
- D. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- E. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- F. Control Relays: Auxiliary and adjustable time-delay relays.
- G. Standard Displays:
 - 1. Output frequency (Hz).
 - 2. Set-point frequency (Hz).
 - 3. Motor current (amperes).
 - 4. DC-link voltage (VDC).
 - 5. Motor torque (percent).
 - 6. Motor speed (rpm).
 - 7. Motor output voltage (V).
- H. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.
- I. Fabrication:
 - 1. Enclosure: NEMA 250, Type 1.
 - 2. Finish: Manufacturer's standard enamel.

2.7 LONG LEAD FILTER, IF REQUIRED

- A. Install a dV/dT filter for motor lead lengths between VFD and motor exceeding 150feet for 480V motors. (Not required for 208/230 VAC motors). VFD Carrier Frequency shall be set to the lowest allowable setting which ambient sound level will allow, preferably 1-2 kHz.
- B. Filter manufactured by TCI (Trans-Coil. Inc. - Milwaukee, WI), part number VLK**a01EX, or pre-approved successor, where ** is equal to or greater than the VFD Output Full Load Rated Amps. Filter shall be in a UL listed enclosure.
- C. The dV/dT Filter shall be warranted for a minimum of one year.
- D. Locate filter within 10 (wire) feet from the VFD that it services.

- E. Set the VFD carrier frequency to 8 kHz or below and operating frequency to 60 Hz or below. 2Hz carrier frequency is recommended.

2.8 HARMONIC FILTER, WHEN REQUIRED

- A. Design Engineer will determine before a project is bid as to the need for Harmonic Filters. If needed, they shall be listed on the VFD Schedule.
- B. If a harmonic filter is required for the line side of a VFD, it shall be a TCI (Trans-Coil. Inc. - Milwaukee, WI), Series HG7 Harmonic Guard Series, Drive Applied Filter, or approved equal.
- C. The filter is required to be removed from the line power whenever the VFD is not running. This shall be accomplished by a contact at the VFD/Power Interface Box, which will close when the VFD is running. Filters that do not disconnect from the line voltage when the VFD is not running will not be accepted.
- D. The filter shall be:
 - 1. UL listed (industrial control panel)
 - 2. In a UL Type 1 enclosure
 - 3. Have a three-year warranty from date of startup
 - 4. The filter shall be of the following model number for a 480V VFD: HGXXXAW01XM, where XXX represents the horsepower of the VFD, or pre-approved successor.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. The VFD manufacturer shall provide certification that heat test has been completed.
- B. The Electrical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.

3.2 INSTALLATION

- A. Install variable frequency drive equipment in accordance with the manufacturer's instructions.
- B. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.
- C. Provide engraved phenolic nameplates under the provisions of Section 26 05 53.
- D. Connections: All conduit connections to the VFD shall be by flexible conduit.

- E. Input, output, and control wiring shall each be run in separate conduits.
- F. All interlocking required by the drive manufacturer shall be the responsibility of the Electrical Contractor.

3.3 MANUFACTURERS FIELD SERVICES

- A. The Manufacturer shall provide local, in-house warranty and service backup. Factory-trained personnel specifically trained for electrical component maintenance and troubleshooting must perform this service backup.
- B. The VFD Manufacturer shall supply the Name, Business Address, and Phone Number of the Designated Service Supply, which will be performing any Warranty Service work. This information must accompany the VFD Submittals.
- C. VFD manufacturer shall have the following available:
 - 1. Service Engineer
 - 2. Training/Service Schools
 - 3. 24-hour phone service

3.4 USER AGENCY TRAINING

- A. Training shall be provided for users if an approved manufacturer or drive series is new to the university or if user deems training necessary during the project design phase. If training is required, then the system manufacturer or authorized distributor shall provide training for users. The initial session to occur when Owner accepts the system. Follow-up sessions shall occur within 1 year after acceptance. All training sessions shall be independent (not concurrent). The initial and review sessions shall consist, minimally, of instruction as follows:
 - 1. Initial Session: On Site Personnel Training including classroom as well a mechanical room for hands-on portion:
 - 2. Four hours of instruction including an overview of the system and its capabilities, what to do in case of alarm or trouble.
 - 3. Four hours of instruction as in both items above in addition to maintenance instruction on each type of device connected to the system, all modules involved in the control panel and all aspects of user-accessible programming.
 - 4. Personnel Factory Training: 4 workers to 3 day training school at manufacturing facility. Training shall include, but not be limited to: product features/design, application/start-up programming, and service/component replacement procedures. Successful bidders are required to conduct both on-site and factory training once in an 18 month window, or sooner if equipment changes significantly. Training shall be at the expense of the manufacturer. Lodging, meals and transportation are an Owner expense.

3.5 STARTUP AND COMMISSIONING

- A. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.

- B. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.
- C. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.
- D. Document settings in the Operations and Maintenance manual.

END OF SECTION 262923

SECTION 263200 - GENERATOR ASSEMBLIES

PART I - GENERAL

1.1 SUMMARY

- A. A natural gas-powered engine generator set shall be provided as the required emergency power source for each new building that is 25,000 square feet or larger.
- B. The engine generator set shall provide three-phase power to all code-required electrical devices and systems including egress lighting. In addition, it shall provide power to all equipment and systems that are essential to basic building functionality as well as others deemed to be critical service. These include:
 - 1. Sump Pumps
 - 2. Ejector pumps
 - 3. Perimeter heating system pumps (where applicable).
 - 4. DDC Control system
 - 5. HW heating pumps
 - 6. Control air compressors
 - 7. Sewage pumps
 - 8. Card Access (if not backed-up by a battery system).
 - 9. Security System (If not backed-up by a battery system).
 - 10. Elevator cab lighting
- C. The elevator starting current requirements shall be included in the design of the emergency power system to allow the emergency generator adequate starting capacity to operate the elevator upon transfer.

1.2 PERMITS

- A. A permit certified by the Office of the State Fire Marshal is required to be granted prior to the use or testing of the emergency generator.
- B. Provide an EPA permit for the generator assembly when required.

1.3 PROTOTYPE TESTS AND EVALUATION

- A. Prototype tests shall have been performed on a complete and functional unit. Component level type tests will not substitute for this requirement. Prototype testing shall comply with the requirements of NFPA 110 for level 1 systems.

1.4 SUBMITTALS

- A. Emergency generator load calculations shall be submitted to verify that the loads associated with the equipment, devices and systems listed in this Section will be powered upon transfer.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. CAT

B. Cummins

C. Kohler

2.2 NATURAL GAS ENGINE-GENERATOR SET

A. The generator set shall be provided with automatic transfer switch, complete instrumentation, vandal resistant enclosure where applicable, and block and jacket heaters. The prime mover shall be natural gas powered.

2.3 PERFORMANCE

A. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.

B. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.

C. The natural gas engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

D. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.

2.4 ENGINE

A. The engine shall be natural gas, 4 cycle, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:

1. An electronic governor system shall provide automatic isochronous frequency regulation.
2. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet.
3. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with 50/50 ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact per OSHA requirements.
4. An electric starter(s) capable of three complete cranking cycles without overheating.
5. Positive displacement, mechanical, full pressure, lubrication oil pump.
6. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
7. Replaceable dry element air cleaner with restriction indicator. Flexible supply and return fuel lines.
8. Engine mounted battery charging alternator, 45 ampere minimum, and solid-state voltage regulator.

2.5 AC GENERATOR

A. The AC generator shall be synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.

- B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
- D. Two embedded RTD per phase and temperature indication equipment shall be provided.

2.6 ENGINE-GENERATOR SET CONTROL

- A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- B. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. The control shall be UL508 listed, CSA282-M1989 certified, and meet IEC8528 part 4. All switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Standard 801.2, 801.3., and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance.
- D. The generator set mounted control shall include the following features and functions:
 - 1. Three position control switch labeled RUN/OFF/AUTO. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 - 2. Red "mushroom-head" push-button EMERGENCY STOP switch. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
 - 3. Push-button RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
 - 4. Push-button PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
 - 5. Generator Set AC Output Metering: The generator set shall be provided with a metering set including the following features and functions:
 - a. 2.5-inch, 90 degree scale analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. These meters shall be provided with a phase select switch and an indicating lamp for upper and lower scale on the meters. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.
 - b. Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.

6. Generator Set Alarm and Status Message Display:
 - a. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions.
 - b. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel:
 - 1) low oil pressure (alarm)
 - 2) low oil pressure (shutdown)
 - 3) oil pressure sender failure (alarm)
 - 4) low coolant temperature (alarm)
 - 5) high coolant temperature (alarm)
 - 6) high coolant temperature (shutdown)
 - 7) engine temperature sender failure (alarm)
 - 8) low coolant level (alarm or shutdown--selectable)
 - 9) fail to crank (shutdown)
 - 10) overcrank (shutdown)
 - 11) overspeed (shutdown)
 - 12) low DC voltage (alarm)
 - 13) high DC voltage (alarm)
 - 14) weak battery (alarm)
 - 15) low fuel-daytank (alarm)
 - 16) high AC voltage (shutdown)
 - 17) low AC voltage (shutdown)
 - 18) under frequency (shutdown)
 - 19) over current (warning)
 - 20) over current (shutdown)
 - 21) short circuit (shutdown)
 - 22) ground fault (alarm)(optional--when required by code or specified)
 - 23) over load (alarm) emergency stop (shutdown)
 - c. In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
7. Engine Status Monitoring:
 - a. The following information shall be available from a digital status panel on the generator set control.
 - 1) engine oil pressure

- 2) (psi or kPA) engine coolant temperature (degrees F or C)
 - 3) Both left and right bank temperature shall be indicated on V-block engines.
 - 4) engine oil temperature (degrees F or C)
 - 5) engine speed (rpm)
 - 6) number of hours of operation (hours)
 - 7) number of start attempts
 - 8) battery voltage (DC volts)
- b. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.
8. Control Functions:
- a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
 - b. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
 - c. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
 - d. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
 - e. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature that is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
9. Alternator Control Functions:
- a. The generator set shall include an automatic voltage regulation system that is matched and prototype tested with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.
 - b. Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.

- c. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.
 - d. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
 - e. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
 - f. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
 - g. When required by National Electrical Code or indicated on Project Drawings, the control system shall include a ground fault monitoring relay. The relay shall be adjustable from 100-1200 amps, and include adjustable time delay of 0-1.0 seconds. The relay shall be for indication only and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay which will function correctly in system as installed.
10. Control Interfaces For Remote Monitoring:
- a. All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:
 - b. Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
 - c. One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
 - d. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
 - e. A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
 - f. The control shall be provided with a direct serial communication link for the LonWorks communication network interface as described elsewhere in this specification and shown on the Drawings.
 - g. The remote monitor controller shall have Ethernet capability connection for remote monitoring and control.

2.7 BASE

- A. The engine-generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.

2.8 GENERATOR SET AUXILIARY EQUIPMENT AND ACCESSORIES

A. Coolant Heater:

1. Engine-mounted, thermostatically-controlled coolant heater(s) shall be provided for each engine. Heater voltage shall be as shown on the Project Drawings.
2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
3. The coolant heater shall be provided with a 24V DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA110 requirements.

B. Vibration Isolators: Spring/pad type vibration isolators shall be provided. Quantity shall be as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

C. Starting and Control Batteries: Starting battery bank, calcium/lead antimony type, 24 volt DC, sized as recommended by the generator set manufacturer, shall be supplied for each generator set with battery cables and connectors.

D. Exhaust Silencer(s): Exhaust muffler(s) shall be provided for each engine, size and type as recommended by the generator set manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the generator set manufacturers recommendations and applicable codes and standards.

E. Remote Annunciator: A 20-light LED remote alarm annunciator with horn shall be provided. It shall be located as shown on the Drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2.

F. Battery Charger: A UL listed/CSA certified 10 amp voltage regulated battery charger shall be provided for each engine-generator set. The charger may be located in an automatic transfer switch, or may be wall mounted, at the discretion of the installer. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:

1. Loss of AC power - red light
2. Low battery voltage - red light
3. High battery voltage - red light

4. Power ON - green light (no relay contact)
 5. Analog DC voltmeter and ammeter, 12 hour equalize charge timer, AC and DC fuses shall also be provided on the charger.
- G. Outdoor Weather-Protective Housing: Generator set housing shall be provided. It shall be factory-assembled to generator set base and radiator cowling. Housing shall provide ample airflow for generator set operation at rated load in the ambient conditions previously specified. The housing shall have hinged side-access doors and rear control door. All doors shall be lockable. All lockable doors shall have CH751 type lock. All sheetmetal shall be primed for corrosion protection and finish painted with the manufacturer's standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:
1. Primer thickness, 0.5-2.0 mils. Topcoat thickness, 0.8-1.2 mils.
 2. Gloss, per ASTM D523-89, 80% plus or minus 5%.
 3. Gloss retention after one year shall exceed 50%.
 4. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.
 5. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.
 6. Salt Spray, per ASTM B117-90, 1000+ hours.
 7. Humidity, per ASTM D2247-92, 1000+ hours.
 8. Water Soak, per ASTM D2247-92, 1000+ hours.
 9. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
- H. Outdoor Weather-Protective Sound Attenuating Housing (If Required):
1. The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of (As specified by the engineer) dab at any location 7 meters from the generator set in a free field environment. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.
 2. The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and padlockable door latches shall be provided for all doors. Door hinges shall be stainless steel.
 3. The enclosure shall be provided with an exhaust silencer that is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a raincap and rainshield.
 4. All sheetmetal shall be primed for corrosion protection and finish painted with the manufacturer's standard color. All surfaces of all metal parts shall be primed and painted.
 5. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts is not acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.

- I. Fire Extinguisher and Cabinet: A fire extinguisher with a minimum rating of 4A60BC must be installed in an exterior fire extinguisher cabinet in the immediate vicinity of each generator installation in accordance with IL OSFM regulations. The extinguisher must be one from the approved manufacturers listed in Section 10 44 00 of these Facilities Standards.

2.9 TRANSFER SWITCH EQUIPMENT

- A. Complete factory assembled transfer equipment shall be provided. It shall incorporate electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts.
- B. Transfer Switch Ratings:
 1. Refer to the Project Drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosures, and accessories.
 2. All transfer switches and accessories shall be UL listed and labeled, tested per UL Standard 1008, and CSA Approved. Transfer switches used for fire pump applications shall be specifically listed for that service, per NFPA20.
 3. Main contacts shall be rated for 600 Volts AC minimum.
 4. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure, in ambient temperatures of 40 to +50 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
 5. Transfer switch equipment shall have a withstand and closing rating (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the Drawings. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third-party listed and labeled for use with the specific protective device(s) installed in the application.
- C. Construction:
 1. Transfer switches shall be double throw, electrically and mechanically interlocked, and mechanically held in both positions.
 2. Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms suitable for safe manual operation under load. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de-energized conditions.
 3. Main switch contacts shall be high pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent interphase flashover. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
 4. Transfer switches designated on the Drawings as 4 poles shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Equipment using add on accessory overlapping contacts are not acceptable.
 5. Transfer switches that are designated on the Drawings as 3-pole shall be provided with a neutral bus and lugs, sized to carry 100% of the current designated on the switch rating
 6. Enclosures shall be UL listed. The enclosure shall provide NEC wire bend space. The cabinet door shall be lockable by means of a key. Controls on cabinet door shall be key-operated.
 7. Transfer switches shall be mounted in enclosures as designated on the Drawings. Separate enclosures shall be the NEMA type specified. The cabinet shall provide required wire bend

space at point of entry as shown on the Drawings. Manual operating handles and all control switches (other than key operated switches) shall be accessible to authorized personnel only by opening the key locking cabinet door. Transfer switches with manual operating handles and/or non-key operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

- D. Automatic Controls: Transfer switches that are designated on the Drawing as automatic shall be provided with a fully automatic control system, and provisions for manual operation as described in this section.
1. Control shall be solid state and designed for a high level of immunity to power line surges and transients, demonstrated by test to IEEE Standard 587 1980. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs.
 2. Solid state undervoltage sensors shall simultaneously monitor all phases of both sources. Pickup and drop out settings shall be adjustable. Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase. Voltage sensors shall have field calibration of actual supply voltage to nominal system voltage.
 3. Optional: Controls shall be provided with solid state overvoltage sensors, adjustable from 100 to 130% of nominal, to monitor all phases. Provide adjustable time delay of 0.5 to 2.2 sec.
 4. Optional: Controls shall be provided with a solid state over and under frequency sensor to monitor the source(s). Pickup bandwidth shall be adjustable from a minimum of +/- 4% to a maximum of +/- 20% of nominal frequency. Dropout shall be +/- 5% of nominal wider than pickup frequency bandwidth. Adjustable time delay shall be from 0.1 to 15 sec. Automatic controls shall signal the engine-generator set to start upon signal from normal source sensors. Solid-state time delay start, adjustable from 0 to 5 seconds (factory set at 2 seconds) shall avoid nuisance start-ups. Battery voltage starting contacts shall be gold, dry type contacts factory wired to a field wiring terminal block.
 5. A phase sequence monitor and balance module shall be provided to protect against inadvertent phase rotation hookup and monitor for voltage phase imbalance between phases.
 6. The switch shall transfer when the emergency source reaches the set point voltage and frequency. Provide a solid-state time delay on transfer, adjustable from 0 to 120 seconds.
 7. The switch shall retransfer the load to the normal source after a time delay retransfer, adjustable from 0 to 30 minutes. Retransfer time delay shall be immediately bypassed if the emergency power source fails.
 8. Controls shall signal the engine generator set to stop after a time delay, adjustable from 0 to 10 minutes, beginning on return to the normal source.
 9. Power for transfer operation shall be from the source to which the load is being transferred.
 10. The control shall include latching diagnostic indicators to pinpoint the last successful step in the sequence of control functions, and to indicate the present status of the control functions in real time, as follows:
 - a. Source 1 OK
 - b. Start Gen Set
 - c. Source 2 OK
 - d. Transfer Timing
 - e. Transfer Complete
 - f. Retransfer Timing
 - g. Retransfer Complete Timing for Stop

11. The control shall include remote transfer inhibit and area protection features.
12. Transfer switches shall be equipped with field adjustable controls to allow the operator to control the transfer switch operating time during switching in both directions. The controls shall control the time the load is isolated from both power sources, to allow load residual voltage to decay before closure to the opposite source. The transfer switch operating speed control feature shall have an adjustable range of 0 to 7.5 seconds. Phase angle monitor is not an acceptable substitute for this feature.

E. Front Panel Devices:

1. A key-operated selector switch shall be mounted on the cabinet front. It shall provide the following positions and functions:
 - a. Test - Simulates normal power loss to control for testing of generator set. Controls shall provide for a test with or without load transfer.
 - b. Normal - Normal operating position.
 - c. Retransfer - Momentary position to override retransfer time delay and cause immediate return to normal source, if available.
2. A key-operated switch with standby and normal positions to manually switch between the standby and normal source shall be provided.
3. Lamps that indicate transfer switch position and source availability shall be provided.

F. Non-automatic Controls:

1. Transfer switches designated on the Drawings as Non-Automatic shall be provided with a non-automatic control. The control shall operate the transfer switch position either by a remote contact opening or closing, or by a front panel mounted selector switch. The selector switch shall be a three position switch. In the center Auto position the transfer switch shall transfer and retransfer in response to input signals as shown. The key shall be removable with the selector switch in the Auto position only. Turning the selector switch to the Emergency position shall transfer load to an energized emergency power source. Turning the selector switch to the Normal position shall transfer load to an energized normal power source.

G. Accessory Items: Transfer switches shall be equipped with accessories as follows:

1. Transfer switches that are designated on the Drawing as automatic shall be provided with a fully automatic control system, and provisions for manual operation as described in this section.
2. Meters: Provide an AC Voltmeter, an Ammeter, and a Frequency meter; 2.5 inch, analog, 2% accuracy. Provide a phase selector switch to read L-to-L voltage and current of both power sources.
3. Exerciser Clock: Provide solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. Provide a with/without load selector switch for the exercise period.
4. Battery Charger: Provide a float charge battery charger rated 10 amps. DC output voltage shall be as required for the starting batteries. An ammeter shall display charging current. The battery charger shall have fused AC input and fused DC output. Include fault indications and Form C contact for AC Fail, High Battery Voltage, and Low Battery Voltage.
5. Manual Selector Switch: Provide a manual/automatic retransfer selector switch to provide either automatic retransfer after the retransfer time delay, or a manual retransfer when selected by an operator.
6. Load Shed: Provide a load shed relay, to move the transfer switch from the emergency position to a neutral position, on receipt of a signal from a remote device.

7. Signal Module: Provide signal module, to delay the transfer and retransfer of the switch for up to 50 seconds to provide a pretransfer warning signal contact. Provide signals for the following conditions:
 - a. Source 1 available
 - b. Source 2 available
 - c. Test/exercise
 - d. Backup source available
 - e. Contacts for these functions are to be form C type, rated for 120 VAC or 30 VDC at 4 amps.

PART 3 - EXECUTION

3.1

END OF SECTION 263200

This section of the *U / S Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 264100 - LIGHTNING PROTECTION SYSTEM

PART I - GENERAL

1.1 SUMMARY

- A. Coordinate with owner to see if new or remodeled building will require a lightning protection system.
- B. The design of the lightning protection systems shall indicate sufficient information in the Contract Documents to allow competitive bidding.

1.2 STANDARDS AND REFERENCES

- A. The following sources of industry standards shall be used.
 - 1. Lightning Protection Institute (LPI)
 - 2. National Fire Protection Association (NFPA)
 - 3. Underwriter's Laboratories (UL)
- B. All materials, equipment, installation, and arrangement of the system shall comply with the following specific references:
 - 1. LPI-175, Lightning Protection Installation Standard
 - 2. LPI-176, Lightning Protection System Material and Components Standard
 - 3. LPI-177, Inspection Guide for LPI Certified Systems
 - 4. NFPA-780, Lightning Protection Components
 - 5. UL 96, Lightning Protection Components
 - 6. UL 96A, Installation Requirements for Lightning Protection Systems

1.3 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 780.
- B. Perform work in accordance with UL 96A and provide independent UL Master Label inspection. Upon passing UL Master Label inspection, provide Master Label Certificate to F&S, and post framed copy in the room containing the Service Entrance to the building.
- C. Master label Certificate shall be posted to the UL website at lps.ul.com.

PART 2 - PRODUCTS

2.1 Materials

- A. All LPS materials shall be copper unless mounted on surfaces where galvanic action is possible, such as Aluminum flashing, etc.

PART 3 - EXECUTION

3.1

END OF SECTION 264100

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Photometric Data: Submit manufacturer's data on lighting fixtures, assembled by luminaire "type" in alphabetical order, with the proposed fixture and accessories clearly labeled. Include photometric data. Ballast and lamp product data shall accompany fixture submittals. Fixture submittals for LED fixtures shall include driver and LED data.
- B. Samples: Sample fixtures, diffusers and stems may be requested for inspection before acceptance.

PART 2 - PRODUCTS

2.1 FIXTURES, GENERAL

- A. All fixtures shall be UL listed for the environment where they will be installed, including damp or wet label where required.
- B. Polycarbonate lenses shall be used at locations susceptible to abuse and vandalism.
- C. All fixtures shall be installed so that they can be maintained from a common ladder or have access panels and/or catwalks built into the structure for fixture maintenance. Access to these fixtures shall not require scaffolding or other special rigging.
- D. All fixtures must have been marketed for at least 3 years.
- E. In stairwells, light fixtures shall be ceiling mount type except when the mounting height will pose a maintenance problem. Glare shall be considered when wall mounting fixtures. Fixtures shall not be mounted above stair risers, but only at flat landings for accessibility.
- F. Lighting shall be provided in each access compartment of air handling units and other large equipment, with a switch and indicating lamp on the exterior of the chamber.
- G. Where varying levels of lighting are necessary in a room, multiple level switching or dimming shall be installed as appropriate for the space. If very low light levels are necessary, dimmable LED fixtures shall be installed.
- H. Fixture lenses shall be 100 percent virgin acrylic with a minimum thickness of 0.125" inch or greater. Prismatic patterns shall be used except when glare is a problem. Glass lenses shall not be used unless required by the manufacturer or the situation.

2.2 LIGHT EMITTING DIODE (LED) LIGHTING FIXTURES

- A. White LED fixtures for general illumination shall have been tested by the US Dept. of Energy's CALiPER program, IES LM-79 and LM-80.
- B. Color temperature: No greater than 5000K for indoor illumination. 3500K strongly preferred.
- C. All LED luminaires shall have been designed around the LED source. LED lamps marketed as replacements for four foot fluorescent T8s shall never be used.
- D. LED systems shall be modular and allow for separate replacement of the LEDs and driver. "Throw-away" fixtures with non-replaceable components are not permitted.
- E. Warranty: Minimum 3-year manufacturer warranty on LED lamps and drivers.
- F. Provide one (1) spare light fixture for every LED light fixture type used on the project, with the exception of EXIT light fixtures and Emergency Egress light fixtures. Provide three (3) spare

drivers for each LED light fixture type and three (3) spare LED elements for every LED light fixture type used on the project.

2.3 SPECIAL APPLICATION AND FUNCTION:

- A. Low voltage fixtures utilizing MR16 lamps shall be lensed.
- B. 'Clean-room' type fixtures for high purity areas and special laboratory functions shall be triple gasketed, with sealed cam latches.
- C. Warning signs (In Use, Beam On, X-Ray In Use, etc.) shall be LED illuminated with housing and face color as specified.
- D. Task lights shall be equipped with an integral rocker switch.
- E. In environmentally sensitive rooms, enclosures shall be complete with gaskets to form weatherproof seal and UL approved for wet locations.
- F. In cold environments, provide low temperature ballasts with reliable starting to 0 degrees.

2.4 LAMPS

- A. Incandescent lamps shall not be used.
- B. Halogen PAR lamps shall be 130 volts, 2000 hour minimum.
- C. MR16 lamps shall use LED source (no incandescent or halogen).
- D. Lamps, including linear fluorescent, compact fluorescent and high intensity discharge, shall be low mercury type and shall pass all federal TCLP (Toxicity Characteristic Leaching Procedure) test requirements at the time of manufacture.

PART 3 - EXECUTION

3.1 SUPPORT

- A. Where fixtures of considerable weight are used, special hanging anchorage shall be provided.
- B. Fixtures shall be securely supported from the building structure and to the ceiling system. Where recessed fixtures occur in a grid system, install tie wires on 2 opposite corners of the fixture. Fixtures so supported shall be securely fastened to the grid system members with safety tee-bar clips.
- C. Where a fixture occurs under ducts, the width of duct shall be spanned with metal channel suspended and supported at both ends and the fixture attached to the channel.
- D. Provide all pendant mounted fixtures with canopies and ball aligners.
- E. Fixtures provided with chain hangers shall have chain of length to clear ducts, piping and other obstructions. Provide flexible conduit connections to outlet box. Length shall not exceed 6 feet.

3.2 WIRING METHODS:

- A. Lighting fixtures shall be connected to a typical metal conduit, junction box, and wire lighting grid system.
- B. Where required, junction boxes shall be standard 4-inch square or larger with blank cover, located adjacent to recessed unit. The boxes shall be rigidly fastened in place to the steel framing system or structure. Install separate junction boxes for the emergency and normal power sources, but the flexible metal conduit shall terminate at the same junction box on the light fixture.
- C. From the junction boxes, install 1/2-inch flexible conduit to the fixture. Flexible metal conduit of 3/8-inch nominal trade size shall be permitted in the lengths not to exceed 6 feet as part of an approved assembly for tap connections to lighting fixtures.

- D. Modular cabling, flexible whip assemblies, feed through wiring, 'daisy-chain' feeds, tandem wiring and other similar wiring methods are not acceptable for the lighting circuit distribution and wiring system.

END OF SECTION 265100

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 265200 -EXIT AND EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. *Emergency Generator System: If an emergency generator system is present and has adequate capacity, it shall be used to power light fixtures and exit signs. This shall be the preferred backup power source for all buildings.*
- B. *Battery powered lights: Individual battery powered lights and exit signs are only permitted when the above power source is not available or has adequate capacity. These buildings are typically smaller than 25,000 square feet, with no basement and no other requirements for emergency power.*

1.2 REFERENCE STANDARDS

- A. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures
- B. National Electric Code
- C. UL 924 – Standard for Safety of Emergency Lighting and Power Equipment

PART 2 - PRODUCTS

2.1 CIRCUITS

- A. Emergency lighting in stairways, exits and corridors shall be served by circuits entirely independent of other lighting. These circuits shall be supplied from panelboards and feeders separate from that for the general lighting system.
- B. Emergency lighting shall be connected to normally "on" emergency circuits, which shall not be controlled by local switches.

2.2 BATTERY POWERED EMERGENCY LIGHTS

- A. The circuits that provide normal power to battery powered emergency lights shall be normally on, un-switched "night light" circuits that feed corridor, stairway and exit lights. These circuits shall be separate from all other lighting circuits in the building.
- B. Units shall have a 3 year, 100 percent, no cost, complete unit exchange warranty.
- C. Individual emergency lighting units shall use sealed, pure lead, lead-calcium or nickel-cadmium batteries with a ten (10) year life expectancy.
- D. Units shall be capable of automatic 30 second exercise cycling on a 30 day basis, and automatic deep discharge cycling on a 12 month basis.
- E. Units shall have self-diagnostic and self-testing feature with externally visible LED indicators to indicate trouble and malfunction. They shall not contain any audible alarms indicating trouble or malfunction.
- F. Units shall have an external switch or sensor to allow manual initiation of a 30 second and a 30 minute test of the battery and lamps.

- G. Units installed at heights more than twelve feet above the floor, and units covered by a plastic guard, must be capable of being tested using a laser pointer.

2.3 EXIT FIXTURES

- A. Exit signs shall be surface mounted or totally recessed. Edge lit plastic or glass is not permitted.
- B. Exit signs shall be illuminated with red light emitting diode (LED) type lamps. The LED lamps shall appear to form solid letters. Exit signs with the appearance of individual LED lamps are not permitted.
- C. Exit signs shall comply with UL 924. "Self-powered" or non-powered exit signs are not permitted.
- D. The requirements of section 2.3 above shall also apply to battery-powered exit signs.

END OF SECTION **265200**

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 265600 - EXTERIOR LIGHTING

PART I - GENERAL

1.1 REFERENCE STANDARDS

- A. Illumination Engineering Society of North America (IESNA) – Lighting Handbook
- B. American Association of State Highway and Transportation Officials (AASHTO) – Roadway Lighting Design Guide
- C. International Dark-Sky Association (IDA)

1.2 SUMMARY

- A. *Illumination Levels: New outdoor lighting shall be laid out and carefully coordinated with existing adjacent surroundings. Illumination levels, quality and uniformity shall be designed to IESNA and AASHTO guidelines, taking into consideration the traffic patterns and hours of use of the area. If in doubt, the higher level traffic category shall be the basis for design. All fixtures shall be approved by owner representative prior to issuing bid documents. Consideration shall be given to bi-level LED lighting systems using occupancy sensors, if deemed acceptable for the location based on security concerns.*
- B. *Exterior Building Lighting: Shall be provided at entrances and courts to supplement campus lighting and to ensure illumination of steps and building entrances. Exterior lighting shall be installed for security and safety purposes only. Decorative façade lighting, and especially uplighting, are not permitted.*
- C. *Street Lighting: Consult with the owner representative at the beginning of design for direction on which light standard to use. i.e. whether to use decorative or non-decorative style fixtures in the project plus other pertinent information on manufacturers, models and finishes. Poles shall be placed approximately 75 feet apart, or as needed to achieve target illumination. Poles shall be carefully aligned with existing adjacent installations, and set to conform to new established grades. Street lighting shall be designed to also provide adequate illumination levels on adjacent sidewalks.*
- D. *Pedestrian Area Lighting: Average illumination levels for sidewalks shall not less than 0.5 foot-candles (higher if warranted by usage according to the IES Handbook). Refer to Drawing 26 56 00-2. Bollard type lights are not permitted. Duplicate rows of street light and pedestrian poles along the same street are not permitted.*
- E. *Parking Lot Lighting: Average illumination levels shall be not less than 0.5 foot-candles.*

1.3 SUBMITTALS

- A. *[Note to PSC: PSC shall submit point-by-point calculations for exterior lighting areas with drawing review submittals. Include average horizontal and vertical foot-candle levels, uniformity ratios and lighting power density.]*

PART 2 - PRODUCTS

2.1 GENERAL

- A. *Efficient: [Note to PSC: Per the Illinois Climate Action Plan (iCAP) goals, LED systems are the standard for all exterior lighting applications. Exterior illumination shall be provided by the most efficient light source compatible with the existing area lighting, on a total life cycle cost basis.]*
Incandescent and linear fluorescent sources are not permitted for exterior illumination.

- B. Vandalism: Fixtures subject to vandalism by location or elevation shall have acrylic or UV-stabilized polycarbonate lens and tamper-resistant hardware. Fixtures protected from vandalism by elevation or location may have glass lens.
- C. Dark-Sky Friendly: Fixtures shall be full cutoff (except as below). Total up-lighting levels shall not exceed that allowed under LEED credit SS-8, "Light Pollution Reduction".
- D. Voltage: Operating voltage of exterior lighting systems shall be limited to 480 volts or less.
- E. All Exterior lighting to be reviewed and approved by the Owner representative.
- F. Coordinate with Owner Representative for which pole get GFI receptacles in the poles.

2.2 EXTERIOR BUILDING LIGHTING

- A. Fixtures shall be full cutoff, wall pack or recessed canopy type. If used for egress lighting, locate any batteries remotely in a heated space.

2.3 STREET LIGHTS

- A. Each pole shall be individually fused, with an in-line fuse located in the pole base.
- B. Provide a ground rod for all poles.

2.4 PEDESTRIAN AREAS – GENERAL LIGHTING

- A. Pole shall be 4" straight round aluminum, 14' height, powder coated smooth black, surface mounted to a concrete foundation raised 8" above finish grade, or approved equal.
- B. Luminaire shall be Lithonia, 4000k, KAD-LED, black in color, or approved equal.
- C. Each pole shall be individually fused, with an in-line fuse located in the pole base.
- D. Provide a ground rod for all poles.

2.5 PARKING LOTS

- A. Fixtures to include a pole mounted motion sensor that dims the fixture to 30% power when no movement is detected. Each fixture shall include a bi-level control that when activated, overrides the motion sensor to maintain full light output. Fixtures shall include transient voltage surge suppressor, one fuse, and a NEMA twist lock receptacle, (no control).
- B. Luminaires shall be arm or spider mounted round cylindrical cutoff fixture.
- C. Each pole shall be individually fused, with an in-line fuse located in the pole base.
- D. Provide a ground rod for all poles.

2.6 LAMPS

- A. Color temperature shall not exceed 4500K, and shall be coordinated with the existing adjacent area lighting.
- B. All fixtures shall use vertical mounted lamps wherever possible.
- C. Lamps shall be low mercury type and shall pass all federal TCLP (Toxicity Characteristic Leaching Procedure) test requirements at the time of manufacture.
- D. LED Lamps shall be field replaceable modules. Non-repairable fixtures shall not be used.

2.7 BALLASTS AND DRIVERS

- A. LED drivers shall be field replaceable and integrated with fixture housing for thermal management. Non-repairable fixtures shall not be used.
- B. Drivers shall include a five (5) year manufacturer's warranty.

2.8 RACEWAY AND CABLE

- A. Power Supply: Power for campus lighting shall be furnished from the nearest campus building with available and accessible power. Lighting control shall be located in the building transformer room. Refer to Section 26 09 23 – Lighting Controls and Drawing 26 56 00-4, Campus Lighting Control Schematic.
- B. Under Paved Areas or Plants: Where cable is routed under paved streets, paved driveways, sidewalks, or areas with planting, a 2-inch PVC conduit shall be provided. This conduit shall have a bushing on each end and extend a minimum of 1 foot beyond the pavement or planting. This conduit shall be located a minimum of 24 inches below the concrete. If not, it shall be encased in concrete.
- C. Conduit: Campus lighting conductors shall be routed in 1-inch PVC conduit.
 - 1. Poles with concrete bases shall have the PVC conduit routed through the pole's foundation to the base of the pole.
 - 2. Poles of the tamp-in type shall have the PVC conduit routed to a below grade junction box. Underground conductors shall be routed from the below grade junction box to the base of the pole.
 - 3. The underground junction boxes shall be precast polymer concrete, sized per the National Electrical Code, have covers flush with finished grade, and have covers engraved with the word "LIGHTING".
- D. Wiring Connections: Wiring connections in light standards shall be made in accordance with high quality workmanship. They shall include a thorough overall coating of insulating paint. In lieu of coating with insulating paint, connections may be made with weatherproof wire nuts. Wire nuts shall incorporate a flame resistant shell rated for 105 degrees C (221 degrees F) as well as non-hardening sealant, to completely seal out moisture, which remains stable from 140 degrees C (-40 degrees F) to 105 degrees C (221 degrees F). Wire nuts shall be UL 486C listed.

END OF SECTION 265600

This section of the *UIS Facilities Standards* establishes minimum requirements only.
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SECTION 266000 - COMMON MOTOR REQUIREMENTS

PART I - GENERAL

1.1 This section contains the requirements for single phase and three phase electric motors utilized at the University. It is the responsibility of the designer to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities.

1.2 APPLICATION

- A. Single phase motors for shaft mounted fans or blowers.
- B. Three phase motors for fans, pumps, blowers, or air compressors.

1.3 REFERENCE STANDARDS

- A. Motors and motor controls shall be designed, built, and tested in accordance with the latest revision of the following standards:
 - 1. IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
 - 2. NEMA MG 1 - Motors and Generators
 - 3. NFPA 70 - National Electrical Code

1.4 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than three horsepower.
- C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, relubrication provisions, and wiring instructions.
- D. Construction documents shall include a schedule of all motors including the following information:
 - 1. Manufacturer
 - 2. Rated Horsepower
 - 3. Voltage(s)
 - 4. Number of Phases
 - 5. NEMA Frame
 - 6. Full Load Amps (FLA)
 - 7. Nominal Speed

8. Efficiencies (Guaranteed, Nominal)
9. Label

1.5 OPERATION AND MAINTENANCE DATA

- A. Operation Data: Include instructions for safe operating procedures.
- B. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacture of electric motors for similar use, and their accessories. Acceptable manufacturers must have a minimum of 5 years documented product development, testing, and manufacturing experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Motors 3/4HP and smaller may be single phase, 60 Hz. Single phase 3/4HP motors shall be a minimum of 208V.
- B. Motors larger than 3/4HP shall be three phase, 60 Hz.
- C. All motors shall be selected and applied such that they are capable of powering associated equipment at full design load/capacity without utilizing the service factor of the motor.
- D. The motor selected shall be an NEMA Premium Efficient motor.
- E. Motors located in wet locations shall be totally enclosed.

2.2 CONSTRUCTION REQUIREMENTS

- A. Acceptable manufacturers
 1. Marathon XRI Premium Efficient series
 2. Siemens GP100 series
 3. Baldor Premium Efficient series
 4. Toshiba CT Premium Efficient Series

B. Design

1. Open drip-proof (ODP) or totally enclosed fan cooled (TEFC), except where specifically noted otherwise.
2. Insulation System: NEMA Class B or better. Motors supplied by VFD's shall have NEMA Class F insulation as a minimum.
3. Design for continuous operation in 40 degree Centigrade environment.
4. Motor starting current shall be limited to no more than 7 times full load current.
5. Motors in Variable Frequency Drive (VFD) applications shall be "Inverter Approved" or "VFD Approved".
6. Explosion-proof motors shall be UL approved and labeled for hazard classification, with over temperature protection.
7. Bearings: Greased lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication.
8. Visible name plates shall be stainless steel, 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, and nominal and guarantee efficiencies.
9. Wiring Terminations
 - a. Motor leads shall be stranded copper and shall be permanently identified and brought out into the motor terminal box through a neoprene gasket. Conduit opening suitable for locknut type connector. Include UL listed ground lug in terminal enclosure.
 - b. For fractional horsepower motors where connection is made directly, provide conduit opening suitable for locknut type fitting in end frame.

2.3 SINGLE PHASE MOTORS

- A. Acceptable single phase motors are; Split Phase, Permanent Split Capacitor, and Capacitor Start.
- B. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
- C. Service Factor: Shall be a minimum of 1.0.
- D. Multiple Speed: Through tapped windings.

2.4 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Torque: NEMA Design B characteristics.
- B. Motor Frames: NEMA Standard T-Frames. Motor frame and end brackets shall be a minimum of grade 25 cast iron construction.
- C. Thermistor System shall be provided when specified in construction documents. Three (3) PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter. Refer to *Section 26 29 13 - Motor Control*.

- D. Bearings: Rated for minimum L-10 life of 40,000 hours, with an external load per NEMA 1-14, and an L-10 life of 100,000 hours in direct coupled applications. Stamp bearing sizes on nameplate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Motors and associated devices shall be installed in accordance with the NEC requirements and in strict accordance with manufacturer's instructions.
- B. Install securely on a concrete housekeeping pad. Mount ball bearing motors with shaft in any position.
- C. Final wiring connections to all motors shall be made with stranded wire. All final wiring connections to any motor shall be in a Liquidtight Flexible Metal Conduit for the last six feet. Flexible Metal Conduit type is not acceptable, except in plenum spaces where a maximum of 4 feet of FMC shall be used. Per NEC, LFMC is not acceptable in plenum spaces.
- D. Testing: Record actual voltage and current readings at each motor in accordance with *Section 26 08 10 – Electrical System Start-Up*.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. While being stored, motors shall have their shafts rotated periodically to protect bearings. For extended outdoor storage, remove motors from equipment and store separately. Prior to energizing the motor, a polarization index and MEG reading shall be performed and the results shall meet NEMA MG1 recommendations for new motors. Documentation shall be kept to verify rotation during storage and electrical test performed prior to startup.

3.3 Warranty

- A. Vendor shall provide the standard form of written guarantee and warranty covering defects in materials and workmanship for the equipment. The guarantee and warranty shall be for a period of one year from the date of final acceptance of the equipment by the University. Date of the acceptance shall be defined as the date that the University assumes operation of the equipment.

END OF SECTION 266000

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 270000 – COMMUNICATIONS

PART I. GENERAL

1.1 SUMMARY/OVERVIEW

1. This standard specifies requirements for communications systems within and between buildings. It specifies a communication system with a definite topology and required distances. It specifies media by parameters that determine performance to ensure interconnectivity.
2. Communications encompasses all forms of information transport and processing, including voice systems, data networks, video, control systems, security cameras, wireless, cellular, and audio. All are communications ingredients of a modern building.

1.2 REFERENCES

1. Wiring standards will follow *EIA/TIA-568, Commercial Building Wiring Standard* Electronic Industries Association and Telecommunications Industry Association (EIA/TIA).
2. Pathways and equipment spaces will follow *EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces*.
3. Cable and wire placement and installation will follow the recommendations of the *Telecommunications Distribution Methods Manual*, Building Industry Consulting Services International (BICSI).
4. All conduit placement and installation will follow the *National Electrical Code (NEC)* and recommendations of *Building Industry Consulting Service International (BICSI)*.
5. All work and materials will comply with all Federal and State laws, municipal ordinances, codes, regulations, and direction of inspectors appointed by proper authorities having jurisdiction.
6. Part 68-FCC rules will apply for communications equipment and system.
7. *Manual on Uniform Traffic Control Devices*, U.S. Department of Transportation
8. *American Disabilities Act*
9. *Illinois Accessibility Standards*

1.3 SYSTEM DESCRIPTION

1. The communications system is a combination of twisted pair copper conductor-standard voice and data cable, fiber optic cable, coaxial cable, protectors, station jacks, terminating hardware, racks, wire management panels, surge protectors, patch panels, equipment rooms, wireless devices, antennas, security cameras, digital signage, and active network hardware.
2. Network switches are connected to routers in HSB and UHB. The routers are connected to the ICCN via single mode fiber optic cable. The UIS telecommunications system is connected

to the AT&T Central Office through a separate “main distribution frames” (MDF’s), also referred to as “nodes”.

3. Each Node is interconnected to a group of buildings, and each building has an Intermediate Distribution Frame (IDF). The IDF can be a stand -alone room or it can be incorporated into a Communication Equipment Room (CER). Depending on the size and jack density of a building there can be multiple CER’s in a building. Typical design should allow for a CER per floor in a building. In new buildings Floor Distribution Frames (FDF) are to be incorporated into rooms.
4. Campus fiber is installed in a combination of ring and star topology. Most fiber is routed to the primary data center located in HSB. Some fiber is routed to a redundant data center in UHB. All multi-mode fiber originates in the HSB primary data center. There is a 100 strand fiber between HSB and USB.
5. Any new building will be fed with SM fiber served from the UHB redundant data center and HSB primary data center.
6. Existing fire alarm cable is either OM1 or OM multi-mode cable. All new fire alarm cable shall be OM3 multi-mode.
7. All station jack wiring is terminated at a CER for data and FDF for voice.

1.4 DRAWINGS AND SPECIFICATIONS

1. The commissioned Project Architect/Engineer shall provide floor plans that show the locations of existing and new IDF’s, CER’s & FDF’s. The floor plan drawings may be submitted in following format:
 1. AutoCAD compatible drawing files scaled to the true dimensions of the building. AutoCAD Release 2013 formatted drawings are preferred; however a minimum of Release 2004 will be accepted.
2. Drawings shall also show the proposed locations for all communications outlets, and the CER or FDF destination of each outlet.
3. In addition, all conduits, raceways, cable trays, floor ducts, junction boxes, camera mounts, wireless access locations, pull boxes, and manholes shall be shown for all proposed communications facilities.
4. All communications drawings shall be separate from other disciplines, and will be identified as Telecommunications and System Drawings within the Electrical section.
5. Floor plan drawings shall include separate layers identifying the floor plans with distribution raceway and voice and data station outlets.
6. Unscaled drawings shall be provided for distribution and riser cables showing:
 1. Backbone distribution cable routes.
 2. Service entrance.
 3. Riser distribution cable routes.

4. Distribution cable support systems.
 5. Type, size, sheath, gauge and length of all cables except station cables.
 6. All splice locations with cable number and count.
 7. Protector location and count.
 8. Terminal locations and quantities of major hardware components.
7. Plans or details of Node/Main Distribution Frames (MDF), Intermediate Distribution Frame (IDF), Communications Equipment Rooms (CERs), and Floor Distribution Frames (FDFs) showing:
1. Room layout (plans and elevations) showing location of splices, backboards, protectors, protector counts, frames, racks, mounts, power supplies, ground bus, and cable counts.
 2. Terminating location of distribution, station and riser cables.
 3. Riser cable count and number of station jacks to be terminated.
 4. Dimensions for devices and fixtures.
 5. Details of special supports that are required for clarification.

1.5 SUBMITTALS

1. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
 1. Compliance with each requirement of these documents.
 2. All component options and accessories specific to this Project.
 3. Manufacturer's installation instructions.

1.6 QUALITY ASSURANCE

1. Minimum qualifications for Telecommunications Contractors are:
 1. The Contractor shall have been in existence for a minimum of 5 years.
 2. The Contractor shall specialize in the installation of structured cabling systems of equal scope, quality, type, and complexity to that required herein.
 3. The Contractor shall be a member in good standing in BICSI for at least 5 years prior to bid time. Provide verification of membership.
 4. The Contractor will own, at time of bid, all required testing equipment called for in the specifications. Technicians responsible for operating testing equipment will have successfully completed all manufacturers approved training courses for the successful operation of the testing equipment.

5. The Contractor shall be an authorized dealer for the structure cabling solution for at least one year prior to bid time. This is to include fiber optic cable, copper unshielded twisted pair cable, and jacks and patch panels.
6. The principal members and key personnel to be assigned to the project shall each have a minimum of 10 years experience in completing projects of equal scope, quality, type, and complexity to that required herein.
7. Minimum of five structured cabling systems, of similar size and scope, installed and operational for a minimum of one year.
8. Minimum of one BICSI Registered Communications Distribution Designer (RCDD) employed or contracted by the Contractor.
9. Project Lead Technician:
 - a. Trained and certified by the structured cabling system solution manufacturer.
 - b. Minimum 5 years experience as Lead Technician on structured cabling system projects of similar size and scope.
 - c. BICSI Installer Level 2 certification.
10. Project Technicians
 - a. Trained and certified by the structured cabling system solution manufacturer.
 - b. Minimum 2 years experience on structured cabling system projects of similar size and scope.
 - c. BICSI level 1 or level 2 installer certification.
 - d. Local services facility within 100-mile radius of project location.

1.7 DEMOLITION

1. All communications jacks, cabling, terminals, or other hardware shall be disconnected and removed by certified Telecommunications Contractor.
2. Coordination of demolition activities with the department will be strictly enforced to minimize service disruptions.

1.8 SEQUENCING and SCHEDULING

1. If it is necessary to make connections to any University facility already in service, the Contractor shall request a date for making such connection at least 24 hours in advance so that Information Technology Services (ITS) can coordinate the timing and information and make the connection to preclude an adverse impact on on-going operations.

1.9 WARRANTY

1. The Contractor shall warrant all equipment, material, cable and workmanship for a minimum period of 2 years following acceptance.
2. During the warranty periods, the Contractor shall repair or replace any defective item at no cost to the University.

1.10 OWNERS INSTRUCTIONS to CONTRACTORS

1. If there are violations of codes, the vendor shall correct the deficiency at no cost to the University.

2. Working conditions shall meet the industry standards for safety and work procedures, and protection of property established by prevailing rules, regulations, codes, and ordinances.
3. The Contractor shall be responsible for locating and protecting all utilities, private and public.
4. The Contractor shall cooperate with the University and maintain access to all areas required by the University. The vendor shall be liable for all damages suffered by the University resulting from Contractor's negligence or lack of cooperation.
5. The cable plant distribution system shall be complete in every respect, constructed in accordance with generally accepted, current standard practices of the telecommunications industry and the detailed requirements of this Standard. It shall be ready to operate in the manner expressed or implied herein, regardless of whether or not full details of such completeness or practices are contained herein.
6. Workmanship and neat appearance shall be as important as the mechanical and electrical efficiency of the system.
7. Contractors shall be responsible for replacing, restoring, or bringing to at least original condition any damage to facilities e.g., floors, ceilings, walls, furniture, grounds, pavement, etc., caused by its personnel and operations. Any damage or disfiguration will be restored at the Contractor's expense.
8. Contractors shall be responsible for ensuring minimal disruption of existing data, video, and voice communications networks to facilities.
9. Outages shall be scheduled only with permission from UIS IT and at its convenience.
10. Unless otherwise expressly provided in the Contract:
 1. Any provision of the standard specifications which require the University to inspect certain material or work shall mean that the University has the option, rather than the obligation, to do so.
 2. Any warranty or guarantee provisions contained in the Contractor's standard specifications shall be of no effect and the warranty and guarantee provisions, if any, of the Contract shall apply.
11. All work areas shall be cleared of all litter, and properly disposed of by Contractor on a daily basis.
12. Vendors shall provide all necessary temporary equipment and material, shall maintain them in a safe and adequate manner, and shall remove them immediately upon completion of work requiring their presence.

1.11 DOCUMENTATION

1. Documentation will consist of Cable Records, Test Records and Record Drawings prepared by the Contractor. They may be submitted in either of the following 2 formats:
 1. AutoCAD compatible drawing files scaled to the true dimensions of the building AutoCAD Release 2013 drawings are preferred; however a minimum of Release 2004 will be accepted.

2. Cable Records: Contractor shall establish complete and accurate cable records showing every splice and cross-connect by cable number and pair number, jack number, and station location. These records shall conform to the cable numbering system established by the University.
3. Test Records: A copy of the completed test record must be furnished to Information Technology Services (ITS) Plant Engineering 30 days prior to substantial completion.
4. As-Built Drawings: Contractor shall prepare and submit the as-built drawings of the completed outside plant infrastructure and inside plant infrastructure with marked up drawings prepared by the AE 30 days prior to substantial completion.
5. Record Drawings: Contractor shall prepare and submit record drawings that conform to the grid system used by the University. The Contractor shall add the distribution cabling system and show as a minimum:
 1. Exact route of all Outside Plant from the Node/MDF to the IDF's, including conduit and buried cable routes.
 2. Cable type, size, count, gauge, and length of all cables placed.
 3. Every splice by cable number and pair count.
 4. The cable numbering system shall conform to the existing number system.
 5. Depth of cable trench
 6. Request Facilities and Services to gather and document GIS information.
6. In addition, Contractor will prepare and submit record floor plan drawings, which will include as a minimum:
 1. IDF, CER, and FDF locations.
 2. Riser drawings showing corrected terminal locations, splice locations, and conduit sizes. Provide copper and fiber counts to each location.
 3. Location of all pull boxes/junction boxes including those boxes in conduit runs between data/voice stations and cable tray or CER.
 4. Specific location of each data or voice jack with cable numbers indicated.
 5. Provide Excel spreadsheet indication jack numbers and room numbers where jacks reside.
7. Mark drawings to record actual installation of:
 1. Field dimensions, elevations and details.
 2. Changes made by modification.
 3. Details not on original drawings.
 4. Coordinate with Facilities and Service to have GIS information gathered and documented.

PART 2. PRODUCTS

2.1 OUTSIDE PLANT INFRASTRUCTURE

A. Conduit

1. Rigid Metallic Conduit (RMC) and Fittings:

- a. Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
- b. Fittings and Conduit Bodies:
 - 1) End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
 - 2) Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
 - 3) Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
 - 4) Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**
 - 5) All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

2. Rigid Non-Metallic Conduit (RNC) and Fittings:

- a. UL listed, NEMA TC2 and TC6 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement.
- b. Fittings: NEMA TC3 and TC9, sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
- c. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

3. High-Density Polyethylene (HDPE) Conduit:

- a. Minimum Size: 2 inches, unless noted otherwise.

B. Manholes

1. Precast Concrete: Air-entrained, 4000 psi compressive strength at 28 days.
2. Type:
 - a. Reinforcing: AASHTO HS-20; bridge loading.

- b. Construction: Monolithic In modular sections with tongue and groove joints.
 3. Shape: Square Rectangular Rectangular with truncated corners As indicated on the drawings.
 4. Dimensions:
 - a. Inside Dimensions: _____.
 - b. Wall Thickness: _____ inches.
 - c. Window for Duct Entry: _____ X _____ inches on each wall, with top of opening _____ feet below top of maintenance hole. As indicated on the drawings.
 5. Requirements:
 - a. Precast extensions needed to reach grade shall comply with the above requirements.
 - b. Include 36-inch diameter grooved opening in top section.
 - c. Necking and Shaft Sections: 30-inch diameter clear opening.
 - d. Include 12-inch drain opening and two (2) one-inch ground rod openings in base section.
 - e. Include cable pulling irons opposite each duct entry window.
 6. Include precast maintenance hole steps at 16 inches on center.
 7. **Manholes with knockout windows for duct entrances will not be permitted.**
- C. Handholes
1. Handholes can be used in a case by case basis with approval from UIS Technology. They are not a substitute for manholes.
 2. Handholes are not to be used in roads, sidewalks or high pedestrian use areas.
 3. Minimum rating for a handhole will be Tier 15 or above.
- D. Copper Cable/Splices
1. A backbone cable shall be standard exchange type telephone cable, which is defined as paired, multi-conductor, thermoplastic insulated, copper cable characterized by a mutual capacitance at 1000 Hz of 0.083 microfarads per mile. All cable provided shall be solid annealed copper.
 2. Only 24 AWG cable shall be used in the distribution network, and shall be based on standard resistance design procedures, taking into account the signaling limits of the switching equipment. Loop resistance calculations shall be based on cable temperature of 68 degrees F. Cable selection shall be equivalent or better than AT&T products coded PIC, ASP, AFMW and ARMM as specified.

- c. Panduit Closet Splice Housing
- d. Panduit Splice Tray

All single mode fiber will be terminated with fusion splice pigtails connectors and adapter panels

In a building where the IDF is in the CER the OSP fiber cable will terminate in the equipment rack. For fiber of 72 strands or more the fiber is to terminate using the following Corning equipment.

- a. Panduit Closet Connect – (72 to 144 Strands)
- b. Panduit Closet Splice Housing Panduit Splice Tray.

All single mode fiber will be terminated with fusion splice pigtails connectors and adapter panels

- 4. All fiber optic cables terminated in the node sites shall utilize Panduit Opticom Cable Systems Cable Management Components including the Closet Distribution Frame (CDF), Fiber Optic Termination Housing model and Splice Housings model. Single mode fiber will be terminated with fusion splice pigtails duplex connectors and adapter panels

F. Documentation

- 1. Contractor shall provide product information for University approval prior to ordering materials.

2.2 INSIDE PLANT INFRASTRUCTURE

A. Intermediate Distribution Frame (IDF) With No Electronics.

- 1. All new building structures shall have 1 Intermediate Distribution Frame (IDF).
- 2. The IDF is the component of the building entrance facility that provides space for the termination of Outside Plant (OSP) and Inside Plant (ISP) cable. It may contain network interface devices and the telecommunications data equipment.
- 3. Because of the variations in size, location, usage, and requirements, IDF sizes and locations shall be evaluated separately. The minimum dimensions for an IDF are 7'-0" by 4'-6".
- 4. The following base minimum standards shall be included in planning entrance terminal locations:
 - a. The space shall be permanently located and not subject to changes due to building alterations or rearrangement of interior partitions, and be accessible from public corridors and spaces. If the space is not readily accessible to Information Technology Services (ITS) employees, keys shall be available, even during off hours.
 - b. The IDF shall be located on the basement level as close as possible to the utility building entrance.

- c. All ceiling heights shall be a minimum of 8 feet 6 inches unobstructed, doors shall be a minimum of 3 feet by 7 feet, open outward, and be equipped with a suitable lock.
- d. The IDF shall be of adequate size to accommodate 50 percent future expansion of the equipment. This shall be determined by the AE.
- e. The space shall be dedicated to telecommunications use only. The space allotted shall be dry and free from the danger of flooding. No exposed water, gas or steam pipes shall enter into or pass through the IDF. Conduits not used to service this room are not permitted to enter or pass through the IDF. No drains, ducts, clean-outs or similar are permitted. Any water, vent, gas, steam pipes, or similar entering this space shall be re-routed at no additional cost to the University.
- f. The IDF space will not be shared with building or custodial services that will interfere with the telecommunications systems. For example, sinks and cleaning materials (e.g., mops, buckets, and solvents) must not be located in this space.
- g. The space shall be free of automatic fire sprinklers except as required by code. If required, the sprinklers shall be equipped with high temperature heads and protective cages shall. Sprinkler piping can only enter the room as a branch and cannot pass through the IDF.
- h. The space shall be free from hazards due to electrical or mechanical equipment.
- i. The IDF shall be locked and keyed to the Information Technology Services (ITS) C key.
- j. A 4" x 10" Ground Bus connected to a #6 ground wire enclosed in a 3/4 inch conduit to the nearest approved metallic ground connection point shall be provided to a building ground GRID meggered less than 5 ohms. The floors, walls and ceilings shall be treated to eliminate dust. The space shall be free of false ceilings.
- k. Lighting shall be a minimum of 50-foot candles measured 3 feet above the finished floor, in the middle of all aisles between cabinets and racks.
- l. Dedicated 120-volt, 20-amp, grounded, non-switched, duplex receptacles, 1 per every 10 linear feet of wall space shall be provided, in addition to any required special circuitry and receptacles.
- m. The IDF walls shall be lined with fire retardant 3/4 inch plywood covering to a height of 8'-6". A minimum of two 4 feet by 8 feet sheets are required for each IDF.
 - 1) Backboards: All backboards required in IDF shall be:
 - (i) Fire retardant plywood, 3/4 inch by 4 feet by 8 feet
 - (ii) Smooth one side
 - (iii) Installed with smooth side exposed
 - (iv) Backboards shall be installed so that the top is eight feet six inches (8' 6") above finished floor.

5. Elements of the IDF facilities design shall include the following:
 - a. Type, size, gauge, and sheath of distribution cables from the Campus Node to the IDF of the new/existing building.
 - b. Type and quantity of terminal hardware for the Campus Node and building IDF.
 - c. Size, type and quantity of associated structures to support or house the cables and terminal hardware, such as:
 - 1) Under floor conduit
 - 2) Building entry conduit
 - 3) Splices
 - 4) Protectors
 - 5) Frames
 - 6) Racking
 - 7) Cable trays
 - d. Location of cables and terminal hardware.
 6. Materials:
 - a. Distribution frames and terminal hardware shall be the BIX Cross-Connect System. All frames and hardware shall be sized to accommodate initial requirements plus 25 percent growth.
 - b. Building entrance protectors terminal hardware shall be sized to accommodate initial requirements plus 25 percent growth. The protector modules shall be solid state with a five pin heat coil over current protector.
 - c. Where additional frames are required, the new frames shall be butted to and aligned with the existing frames.
 - d. All frames shall be installed and grounded in accordance with the manufacturers and industry standard practices.
 - e. Telecommunications Contractor shall install modular, stackable connectors and provide Preformed Armadillo splice cases and other hardware required at the IDF and Node. The distribution side shall be spliced to the shielded stubs of the protectors.
- B. Communications Equipment Rooms (CER).
1. A Communications Equipment Room serves the space needs for larger telecommunications equipment (e.g., networking and computing equipment).
 2. When selecting the CER site, attempt a central location; avoid locations that are restricted by building components that limit expansion. Accessibility for delivery of equipment to the room shall be provided. Accessibility from a public corridor or space is required.
 3. The placement of CERs adjacent to building columns, elevator shafts, stairways, utility chases and exterior walls greatly restricts flexibility with regard to the layout of a raceway system and the subsequent routing of cables and is highly discouraged.

4. The space allotted shall be dry and free from the danger of flooding. The space shall be dedicated to communications use only. Equipment e.g., HVAC controllers, DDC controllers, ducts, or similar systems are not allowed to be installed in CER's. Likewise piping e.g., steam, plumbing, heating, chilled water and condensate will not enter or pass through the room unless they are providing a service to the CER. Items that serve the CER can only enter and terminate inside they room, they cannot pass through to another area. No electrical conduits can pass through or enter the room unless they serve the room. All equipment, piping, and conduit will be relocated at no additional cost to the University. The space shall not be shared with building or custodial services or any other entity. Sinks and cleaning material (e.g., mops, buckets, & solvents) can never be stored in this space.
5. In large buildings, the floor areas shall be "zoned" to assist in the planning of the communications support facilities. Sufficient CERs shall be provided and properly located to limit station wiring runs to 250 cable feet maximum. This requirement shall dictate such zones.
6. The minimum dimensions for a CER are 8' by 10'. However, this shall not be considered the final design unless they have been reviewed and deemed adequate by Information Technology Services (ITS). If a dedicated air conditioner is required to serve the CER, the size of the room shall be enlarged to 9'-6" by 10' to accommodate the unit
7. The standard 8' x 10' CER is designed to include no more than two (2) equipment racks. Each rack shall be equipped with no more than five (5) 48 port data patch panels or four (4) 48 port data patch panels and one fiber optic splice/patch cabinet. High density patch panels will not be accepted. Any CER serving more than 432 data connections shall be enlarged to accommodate additional equipment racks.
8. CER shall be connected to IDF or FDF via conduit or cable tray.
9. All rooms shall be free of all safety hazards, the danger of flooding and suspended ceilings except where required for fire resistive rating.
10. The room shall be located away from sources of electro-magnetic interference at a distance that will reduce the interference to 3.0 V/m throughout the frequency spectrum.
11. HVAC shall be included in the design of the equipment room to maintain a constant temperature 24 hours a day. When active devices (heat producing equipment) are present, a sufficient number of air changes shall be provided to dissipate the heat. A minimum of 1 complete air change per hour is required.
12. Each CER requires a dedicated 100 amp, 30 circuit, panel feed from normal building power. This panel is only for circuits dedicated to the CER. Only circuits terminating in the CER shall be managed from the CER sub-panel. Sub-panels shall provide a minimum of two phases to provide for 208/240 VAC.
13. In order to provision for harmonics loads that are present in network equipment, the feeder neutral shall be sized at 150% the current rating of the hot conductors.
14. A dedicated 120-volt, 20-amp, grounded, non-switched, duplex receptacle, 1 per every 10 linear feet of wall space shall be provided on the walls of the CER. For rack power (per two racks); two dedicated 250-volt, 30 amp L6-30R, grounded, non-switched, receptacles are required. One supplied by the dedicated CER panel and the other by an emergency power panel. In addition two 120 volt, 20 amp, quads loaded with 5-20R

receptacles are required. One side is to be supplied power via the CER dedicated panel and the other by an emergency power panel. Rack power receptacles are to be mounted on the wall adjacent to the equipment rack. **If more than two racks are required due to jack density, Information Technology Services (ITS) is to be contacted. This may require the CER to be larger and additional power outlets may be required.**

15. A 4" x 10" Ground Bus connected to a #6 ground wire enclosed in a 3/4 inch conduit to the nearest approved metallic ground connection point shall be provided to a building ground GRID meggered less than 5 ohms.
16. The walls shall be lined with fire retardant 3/4 inch plywood covering to a height of 8'-6". A minimum of two 4 foot by 8 foot sheets are required for each CER.
 - a. Backboards-All backboards required in CER shall be:
 - 1) Fire retardant plywood, 3/4 inch by 4 feet by 8 feet.
 - 2) Smooth one side.
 - 3) Installed with smooth side exposed.
 - 4) Backboards shall be installed so that the top is 8'- 6" above finished floor.
17. A minimum of three 4" conduits are required to feed a CER. If there are multiple CER's in a building a minimum of three 4" conduits are required between the CER's. The number of conduits can be increased due to complexity of the design and density requirements for the building. Information Technology Services (ITS) Plant Engineer will advise if more are required.
18. Lighting shall be a minimum of 50-foot candles measured 3 feet above the finished floor, in the middle of all aisles between cabinets and racks.
19. The CER shall be locked and keyed to the Information Technology Services (ITS) C key.

C. CER/ FDF Copper Terminations

1. Copper cables (riser and horizontal/station) terminated at the CER or FDF for voice communications shall utilize the BIX Cross-Connect System and sized to accommodate initial requirements plus 25 percent growth.
2. The walls shall be lined with fire retardant 3/4" plywood covering to a height of 8'-6". A minimum of two 4' x 8' sheets are required. Backboards are required in a CER and or IFDF shall be:
 - a. Fire retardant plywood, 3/4" by 4'x 8'.
 - b. Smooth one side.
 - c. Installed with smooth side exposed.
 - d. Backboards shall be installed so that the top is 8'-6" above finished floor.

D. Horizontal Cabling

1. Copper cables (horizontal/station) terminated at the CER for data communications shall utilize equipment frames and patch panels manufactured exclusively by Panduit

CPP48FMWBL. No substitutions are permitted for the following equipment unless noted otherwise:

- | | | |
|----|----------------------------------|--|
| a. | 2-Post Equipment Rack | Panduit CMR19X84S (BOD Substitutions allowed) |
| b. | Equipment Cabinet | Great Lakes GI840N12-242-SS with Fan Assembly FKN12-A3 BOD |
| c. | Category 6, 24 Port Panel | Panduit Mini Com |
| d. | Category 6, 48 Port Panel | OR-PSD66U48 Panduit MiniCom |
| e. | Wire Management Panel Horizontal | Panduit NCMHF2 (BOD Substitutions allowed) |
| f. | Vertical Wire Management | Panduit PEV6 (BOD Substitutions allowed) |
| g. | Vertical Wire Management Door | Panduit PED6P (BOD Substitutions allowed) |
| h. | Rack Mount Power Strip | Trip Lite PDUV15 (BOD Substitutions allowed) |

E. Raceways

1. Conduit

- a. Conduit provided for all communication wiring shall be color coded purple for identification.
- b. Riser conduit runs for distribution cables (both horizontal and vertical), except station outlets, shall be not less than 4 inches trade size. Provide a polypropylene, twisted yellow, rot and mildew resistant, pull rope in all conduits. Minimum size is 3/8 inch O.D., with a 2,400 pounds tensile strength.
- c. All conduit runs for station outlets shall be 1-inch trade size or larger as required. Total length of a conduit run shall not exceed 150 feet, including the distance through pull boxes. The conduit shall be equipped with a plastic or nylon pull line that is rated at 200 pounds test. Conduit runs are to have bushings at both ends and grounded.

2. Cable Tray

- a. All cable trays must be approved by the University prior to their inclusion in drawings and specifications. Wall mounted cable trays placed below the ceiling are preferred to cable trays placed above ceilings. Cable trays placed above ceilings shall be placed in non-restricted, public areas, i.e. hallways. Cable trays placed above office ceilings are not permitted. Cable trays are not permitted above classrooms except when they are dedicated to serve the classroom only.
- b. Wire basket cable trays shall consist of continuous, rigid, welded steel wire mesh and will have continuous T-welded top side wire to protect cable installation and

- installers. Flex-tray, manufactured by GS Metals or others, and its associated accessories are an approved product.
- c. Standard cable trays shall have an electroplated zinc coated finish.
 - d. Cable trays for horizontal distribution cables, utilizing the trapeze hanger method to support the cable trays, shall utilize threaded rods of not less than 1/2 inch in diameter. Center hung supports will not be allowed. Cable trays shall be installed per the manufacturer's specifications.
 - e. At the end of each cable tray run a water fall is to be installed to protect the cables.
3. Cable trays shall be sized for a 40% fill ratio of total fill capacity, plus an additional 50% to allow for growth and future cabling changes
 4. When cable trays are installed above ceiling working space clearance is required for cable installation.
 5. Communication Outlet Boxes
 - a. Boxes for a typically wall outlet (2 Data or more) will be zinc-coated or cadmium plated sheet steel outlet boxes measuring 4 inch by 4 inch by 2-1/8 inches deep, with a double gang plaster ring. Boxes shall be 1 piece stamped sheet steel. No spot welding or riveting will be permitted.
 - b. Boxes for wireless access points and telephone wall outlets will be zinc-coated or cadmium plated sheet steel outlet boxes measuring 4 inch by 4 inch by 2-1/8 inches deep, with a single gang plaster ring. Boxes shall be 1 piece stamped sheet steel. No spot welding or riveting will be permitted.
 6. Copper Riser Cable
 - a. A backbone cable shall be standard exchange type telephone cable, which is defined as paired, multi-conductor, thermoplastic insulated, copper cable characterized by a mutual capacitance at 1000 Hz of 0.083 microfarads per mile. All cable provided shall be solid annealed copper.
 - b. Only 24 AWG cable may be used in the distribution network, and shall be based on standard resistance design procedures, taking into account the signaling limits of the switching equipment. Loop resistance calculations shall be based on cable temperature of 68 degrees F. Cable selection shall be air core, solid conductor insulation with an ALVYN sheath and shall be equivalent or better than AT&T products coded PIC, ASP, AFMW and ARMM as specified.
 7. Horizontal/Station Cable
 - a. Only 23 AWG cable shall be used in the distribution network, and shall be based on standard resistance design procedures, taking into account the signaling limits of the switching equipment. Loop resistance calculations shall be based on cable temperature of 68 degrees F.
 - b. Quantities and locations as indicated in Project Documents.

- c. The minimum data transmission performance level for all station cables shall be a Category 6, 4 pair twisted, 23 AWG solid copper, NEC rated CM flame retardant polyethylene insulation, rip cord, and have a PVC jacket. Acceptable cable surface markings shall indicate: "Verified Level VI" or "Classified Level VI", ("LVL" or "LEV" may be substituted for "Level").
- d. Specific locations or applications may require different cabling configurations.
- e. 1 voice station cable is to be installed for each fire alarm control panel, elevator emergency phone, area of assistance phone, fax machine, and wall phone.
- f. Station cables for data and voice jacks shall have a blue jacket, shall terminate on the telephone jack (top/left) and shall be designated "Voice". Voice cables shall terminate in the FDF identified on the drawings on BIX connecting strips, designated "A" on the designation strip.
 - 1) Panduit PUR6004BU-UY plenum rated Category 6 cable .
- g. Two (2) blue station cables are to be installed for each wireless access point unless specified otherwise.

F. Fiber Optic Riser Cables

- a) The single mode in-building fiber optic cable shall be manufactured by Corning Cable Systems. The specifications represent a gel free, MIC cable, with a NEC rated CM flame retardant sheath designed for riser applications. It has an engineered loss of 1/75 db/KM for 1310/1550 nanometer operation. Substitutions will not be allowed.
- b) Plastic wire ties shall not be used with fiber optic cable. Velcro wire wraps shall be used to prevent excessive crimping of the fiber.

G. Station Cable Termination

- a. Wall Faceplate
 - 1) Single gang plate
 - 2) 4 ports capacity
 - 3) UL 1863 compliant
 - 4) Typical faceplate shall be Panduit Mini-Com, ivory color in existing buildings and white in new buildings. Coordinate final color with other utilities and Information Technology Services (ITS). The exception being faceplates located in the detention area. Faceplates in detention area shall be plastic. Faceplates in detention area shall be secured using tamper security screws.
 - 5) Voice/data outlets shown adjacent CATV drops shall share the same faceplate. Coordinate mounting and termination of CATV cable and drop with Voice/Data faceplate.
 - 6) Clear label cover.
- b. Jack
 - 1) Front loading and frontremovable
 - 2) ANSI/TIA/EIA Category 6 compliant (Tested to T568B-2.1)
 - 3) T568 A/B wiring
 - 4) 22-26 AWG wiring
 - 5) UL 1863 compliant

- 6) Provide icons for Voice, Data, and blank icons for spare ports
 - 7) Color based on cross-connect field identification color code, TDM 12th edition, chapter 7.
- c. Shutter
- 1) Footprint equal to jack
 - 2) Color to match jack
 - 3) Icon included on shutter mount
2. Acceptable Manufacturers
- a. Panduit CJ688TGWH Mini-Com Category 6 RJ-45 jack and CFPL4IWH face plate. Provide shutter for unused spaces.

H. Wireless Communications

- a) The campus wireless is based on IEEE 802.11a, b, g, n, & ac standards, also commonly known as WiFi.
- b) Station jack wall outlets designated for wireless access points shall be zinc-coated or cadmium plated sheet steel outlet boxes measuring 4 inch by 4 inch by 2-1/8 inches deep, with a single gang plaster ring. A 1" conduit shall be installed from the outlet box to the cable tray.
- c) The wireless design for all projects must be approved by Information Technology Services (ITS). Typically Information Technology Services (ITS) will provide the wireless design.
- d) Wireless access points (WAPS) are to be mounted on or below the ceiling grid. Outlet boxes are to be mounted above. A clear area of 24" is required around the outlet for maintenance.
- e) All new projects will be evaluated and include wireless access points strategically placed on the exterior of the building with the intent of providing wireless network coverage in exterior student gathering areas and primary pedestrian walkway approaches to the building.

PART 3. EXECUTION

3.1 OUTSIDE PLANT INFRASTRUCTURE INSTALLATION

A. Conduit and Manhole Placement

1. Manhole Work shall be performed by 2 or more workers, with 1 remaining above ground. Safety regulations shall be strictly adhered to.
2. Access to the manholes shall be coordinated with F&S engineers. 24 hour notice before entering a manhole shall be given.
3. Adequate manhole foundation shall be provided. Pre-cast base section shall be placed on a well-graded granular bedding course not less than 6 inches in thickness and extending to the limits of the excavation. The bedding course shall be firmly tamped and made smooth and level to ensure uniform contact and support.

4. Manholes will be installed level. The manhole frame and lid shall be flush with final finished grade. Grade rings (6 or 12 inch) with a galvanized step are required to anchor a ladder and to bring lid flush with grade.
5. All underground duct systems shall maintain a minimum of 24 inches ground cover throughout.
6. The existing underground duct systems shall be utilized where possible for on-campus distribution of cables to appropriate buildings.
7. Underground conduit shall be installed to those buildings not directly served by the existing duct system. Exceptions to this are those sites served by direct-buried outside plant.
8. Any unusual water seepage in manholes and apparent water leaks in main terminal rooms shall be reported promptly to the University on a daily basis.
9. Excavation
 - a. The Contractor shall be required to do all the excavation for the installation of underground mechanical piping and performance of all auxiliary Work that may be required.
 - b. At its own expense, Contractor shall erect temporary fencing where required or deemed necessary by the University to ensure safety of University personnel, students and visitors, or where deemed necessary by Contractor for securing materials.
 - c. All trenching within public rights-of-way owned by or under the jurisdiction of the City of Springfield shall conform to the appropriate city's standards. The Contractor is responsible for obtaining cut and trench permits and for ensuring that the most current standards are met.
 - d. Special care shall be taken to have all fire hydrants and gate valves on water main kept accessible at all times. To avoid possible major water utility outages, F&S Division requires notification before any tee or elbow fitting on a water main 4 or more inches in diameter is exposed.
 - e. The Contractor shall not obstruct the gutter of any street or driveway, but shall use all proper means to provide for the free passage of surface water along the gutters into storm water inlets. The Contractor shall provide channels where necessary.
 - f. Pavement shall be saw cut at a full depth, in a straight line at a minimum of 1 foot on each side of trench width and 1 inch deep into concrete, if concrete base under asphalt pavement.
 - g. Walks and drives shall be saw cut at existing joints for replacement. Road patches that are near existing joints shall be extended to existing joints. New concrete shall be saw cut 1/3 of total thickness for joints and at intervals not to exceed 15 feet. These saw cuts shall be sealed with rubberized asphalt after cleaning.
 - h. The width of the trench shall be per the Construction Drawings. Where sheeting is required, this width shall be increased by the thickness of the sheeting.

- i. Wherever necessary, the side of the trench shall be shored and braced in strict accordance to the rules, orders and regulations of the State of Illinois and OSHA.
- j. Should the trenching be excavated to a greater depth than that given, the Contractor shall, at his own expense, bring such excavation to required grade with such material as directed, notwithstanding that it may be necessary to bring such material from other localities or to purchase suitable material.
- k. Where groundwater or soft, yielding, or otherwise unsuitable material is encountered in the bottom of the trench, making it an unsuitable foundation for the pipe, such material shall be excavated from the full width of the trench to a satisfactory depth. Said depth shall be a minimum 6 inches. The resulting space shall be back-filled with imported bedding properly compacted to give adequate pipe support.
- l. The material excavated shall be deposited along the side of the trench if space is available in such a manner as to create the least inconvenience possible. If space isn't available the excavated material is to be trucked away at the contractor's expense.
- m. Surplus earth from the trenches, after compacting, shall be removed and disposed of by the Contractor in a proper and legal location acquired by the Contractor or on University property, designated by the University.
- n. All underground construction work, during progress and after completion, shall conform to finish grades.
- o. Major underground conduit structures shall be encased in concrete. Concrete encasement shall be a 5-bag mix with pea gravel aggregate and a 9-inch slump.
- p. All mechanical piping shall be laid on a bed of clean, dry sand no less than 6 inches thick. The space between the pipe and the sides of the trench shall be filled with concrete to a point 6 inches above the crown of the pipe and both sides of the pipe shall be filled at the same time.
- q. The remainder of the trench shall be back-filled with native soil in lifts no greater than 12 inches and shall be mechanically compacted by tamping to maintain a minimum relative density of 90 percent.
- r. Any asphalt pavement cut shall be replaced and shall conform in kind and quality to the type of pavement removed, but in no case, is less than 12 inches of base rock to be placed beneath the pavement. Where plant mix or asphalt concrete surfacing exists, pavement shall not be less than 3 inches in thickness.
- s. All concrete roads shall have expansion joints at intervals not to exceed 45 feet, with 1/2 inch wide joint material at least 6 inches deep. Expansion joints shall be placed between all new and existing concrete.
- t. All new concrete pavements shall be a minimum of 6-bag mix with a minimum of 6 percent and a maximum of 8 percent air entrainment and 2 inch slump. New concrete to match existing surface or to be broom finished as desired by the Owner and is sloped for proper drainage. Concrete pavement shall conform to the requirements of the Cities.

- u. All patches in roads and curbs shall be doweled with ½ inch by 18 inch smooth re-bar spaced not less than 18 inch intervals placed 9 inches into existing concrete. Portion of bar in new concrete shall be greased and paper wrapped.
- v. Curing time with accelerator is 3 days; 7 days without. Traffic load may be delayed up to 14 days beyond cure period.
- w. Field tests shall be conducted to determine compliance of compaction methods with specified density in accordance with:
 - 1) ASTM D2922 - Tests for density of soil and soil aggregate in place by nuclear methods,
 - 2) ASTM D1556 - Tests for density of soil in place by the sand cone method, or
 - 3) ASTM D2167 - Tests for density of soil in place by rubber-balloon method.
- x. Compaction shall be to the following minimum densities, reference ASTM D698 or AASHTO T99 unless otherwise indicated.
 - 1) Sub grade: Under footings or foundation: 100%
All other locations: 95%
 - 2) Barrier material: 95%
- y. Pipe Bedding - Lightly compacted select soil: 80%
 - Carefully compacted select soil: 90%
 - Compacted granular material 80% (ASTM D0249)
 - Barrier material: 95%
- z. Trench Back Fill
 - 1) State Highways - 100% for paved areas and shoulder slope
- 95% for all other areas
 - 2) Paved Roadways, sidewalks and other areas to receive pavement.
 - Top four feet: 95%
 - Remainder of trench: 90%
 - 3) Gravel Roadways: 90%
 - 4) Sodded or lawn areas: 88%
 - 5) Fields: 80% or equal to the density of undisturbed adjacent material whichever is greater unless otherwise indicated.
 - 6) Under-footings, foundations or structures: 100%
 - 7) All other locations: 95%
- aa. Bricks, blocks and other debris removed from trenches shall not be used as fill for the trenches.
- bb. Grass shall be replaced by a method approved by the University.

- cc. Where granular materials are used in lieu of cohesive soils, reduce the above percentages by 15 percent to arrive at the relative density and ASTM D2049 shall apply.
- dd. Moisture Content
 - 1) Compact soils within (+) 2 percent of optimum moisture.
 - 2) Add water, harrow, disc, lade or otherwise work material as required to ensure uniform moisture content specified.

10. Building Entrance Conduit

- a. All new service entrance conduits shall be of 4 inch trade size. They shall provide a 25 percent growth capacity, and shall terminate in the IDF (main terminal room) inside the building.
- b. The University standard requires that a minimum of 3 conduits enter major buildings, 1 to serve each media type (copper and fiber optic) including a spare for future growth. During the process of design and development drawings, Information Technology Services (ITS) will specify the exact number of conduits entering the building based on the number of stations and/or a particular application.
- c. Conduits entering the IDF through the wall shall be reamed and bushed, and terminated not more than 4 inches from the entrance wall.
- d. Building entry conduits shall be 4 inch rigid steel conduit, extending 10 feet from the building foundation.
- e. Provide 4 inch metal base, screw type adjustable plugs with expandable rubber outer surface in vacant conduits at both manhole and building entrance openings in the Main Terminal Room.
- f. All cable filled conduits shall be sealed with 3M Fire Barrier 2001 Silicone RTV Foam conduit sealant manufactured by 3M Fire Protection Products, or approved equivalent, installed in accordance with the manufacturer's tested methods.
- g. Conduits entering the IDF from below shall be terminated 4 inches above finished floor.

B. Cable Placement

- 1. Copper: The following standards relative to pulling telecommunication cables into conduit, ducts and manholes are not to be considered all inclusive:
 - a. Cable shall be installed per manufacture specifications.
 - b. All cable shall be installed free of kinks. A kink is defined as a violation of the manufacturer's specified Minimum Bend Radius for each type of cable.
 - c. Cable shall not be formed into a condition that causes the outside sheath to wrinkle.
 - d. All necessary cable data including maximum pulling tensions, minimum bending radii, shall be obtained by the Telecommunications Contractor from the cable

manufacturer before any cable is pulled. Exceeding the recommended pulling tensions or bending radii is not permitted. Any cable placed that exceeds these requirements shall be replaced by the Contractor at no additional cost to the University.

- e. The equipment used to pull cable shall have adequate capacity to ensure a steady continuous pull.
- f. A suitable flexible feeder tube, cable protectors or sheaves shall be used to protect and guide cable from the cable reel through manholes and into conduit or duct. The radius of the feeder tube shall be as large as possible, but not less than manufacturer's minimum pulling radius.
- g. Pulling rope used may be nylon, polypropylene or manila rope. Bare wire winch line may be used upon approval of the Information Technology Services Plant Engineer.
- h. Basket weave type grips, wedge type pullers, and swivel harnesses may be used for pulling cables within manufacturer's recommended safe working loads.
- i. Only cable pulling lubricants compatible with cable jacket shall be used when pulling cable through conduits.
- j. Petroleum base lubricants shall not be used on neoprene jacketed cables. Green oil soap, or soapstone-type lubricants shall not be used because of tendency to cause gumming and packing in the conduit with them. Pulling lubricants in general shall consist of materials with high dielectric strength.
- k. Before pulling cable through conduit and duct runs, a mandrel or plug approximately the diameter of the conduit shall be pulled through to check for obstructions. If an obstruction is encountered, a mandrel followed by a swab shall be used to clean out any lint or foreign matter.
- l. When cables are installed in their permanent locations, they shall not be bent beyond the radial limitations recommended by the cable manufacturer.
- m. All cables and splices shall be supported by a minimum of 2 cable hooks (4 inches or 7 inches). Horizontal racking for support may utilize 3M brand RC-100 rack adapters, manhole racks, or University approved equivalent.
- n. Preformed Armadillo splice cases or University approved equivalent shall be used for splicing throughout the underground system.
- o. All splices in manholes shall be encapsulated. Re-enterable polyurethane compound shall be used in accordance to manufacturer's specifications.
- p. Spacer webbing shall be permanently adhered to the inside of the case to maintain minimum compound fill.
- q. All splice cases in manholes shall be bonded to common grounding bond strap. 3/8 inch copper bond ribbon shall be placed by Contractor if none is in place. Ribbon shall be clamped across manhole ceiling and extended down each wall to 1 foot above floor.

- r. Underground feeder cable assignment records for splicing cable will be furnished to the Contractor by Information Technology Services (ITS) upon request.
 - s. All splicing shall be performed to industry standard practices.
2. Fiber Optics
- a. All fiber optic cables shall be installed in MaxCell fabric innerduct. In conduit runs where there is no existing MaxCell, the contractor will install 3, 3", 3 cell innerducts. MaxCell shall be installed per the manufacturer's specifications, including a 3-way chain swivel pulling harness and split termination plugs in buildings and the serving manhole.
 - b. Cable shall be installed per manufacture specifications.
 - c. All cable shall be installed free of kinks. A kink is defined as a violation of the manufacturer's specified Minimum Bend Radius for each type of cable.
 - d. Cable shall not be formed into a condition that causes the outside sheath to wrinkle.
 - e. All necessary cable data including maximum pulling tensions, minimum bending radii, shall be obtained by the Telecommunications Contractor from the cable manufacturer before any cable is pulled. Exceeding the recommended pulling tensions or bending radii is not permitted. Any cable placed that exceeds these requirements shall be replaced by the Contractor at no additional cost to the University.
 - f. All fiber optic splicing shall be done by the fusion method.
 - g. Tyco Fosc Series splice cases shall be used for splicing and encapsulation in manholes throughout the campus system.
 - h. All fusion splices for single mode splices shall be shall be made with a maximum loss of .25 db measured at 1550 nanometers.
- C. Safety/Traffic Regulations
- 1. All encroachments in city highway rights of way shall be designed, made and maintained in accordance with the following rules:
 - a. Conformance - *Manual on Uniform Traffic Control Devices*, U.S. Department of Transportation, or applicable statutory requirements of authority having jurisdiction.
 - b. Operations on or about traffic areas and provisions for regulating traffic will be subject to the regulation of governmental agencies having jurisdiction over the affected areas.
 - c. Keep traffic areas free of excavated material, installation equipment, pipe, and other materials and equipment.
 - d. Flagmen - required providing for public safety and the regulation of traffic.
 - e. Warning signs, lights and audible.

- f. Protect all roadways by effective barricades on which are placed warning signs.
- g. Provide barricades and warning signs for open trenches, other excavations and obstructions.
- h. Illuminate by means of warning lights all barricades and obstructions from sunset to sunrise.
- i. Provide an audible warning for all barricades and obstructions at all times for the visually impaired.

D. Acceptance Testing

1. Technology Service Plant Engineering requires 24 hours notification prior to any tests being performed, and may at their option, send representatives to the tests. In addition, the Information Technology Services (ITS) may make their own tests using similar procedures to confirm the written test results furnished.
2. The Contractor shall perform testing of the entire distribution system installed.
3. Copper - Outside Plant and Riser
 - a. Testing of all cable pairs from the Node to the IDF terminations.
 - b. Furnish test equipment and labor to perform test.
 - c. After the cables are in place and spliced end to end, the system shall be tested for shorts, opens, ground, crosses and transpositions. Correct all splicing/terminating defects, and replace all cables when:
 - 1) Cable pair defects exceed 1 percent of the total number of pairs and/or exceed 2 pairs per 25 pair binder group.
 - 2) Cables requiring splicing due to inadequate length or damage repair.
 - 3) All repair and/or replacement of defective material and labor shall be done at no cost to the University.
4. Fiber Optics
 - a. The Contractor shall perform the following test procedures, with written reports furnished to Information Technology Services Plant Engineering. The Information Technology Services (ITS) Plant Engineer shall be notified in advance of all tests, and may, at their option, send representatives to the tests. In addition, the Information Technology Services (ITS) may make their own tests using similar procedures to confirm the written test results furnished.
 - b. The tools used for optical span line testing are the Optical Time Domain Reflectometer (OTDR) and the Optical Loss Test Set. Acceptance Testing of an optical fiber facility enables the University to:
 - 1) Determine that the cable facility as installed will perform as specified and intended.

- 2) Verify that the facility meets the purchase specifications.
 - 3) Confirm that the workmanship (i.e. splicing, cable installation, etc.) is acceptable.
 - 4) Provide records that will aid in future maintenance.
- c. All Single-Mode fibers shall be tested for attenuation at 1310 and 1550 nanometer wavelengths. A record shall be provided of each fiber loss at both wavelengths in both directions. The University will provide blank test forms.
 - d. Acceptance testing consists of an attenuation measurement and a full OTDR signature. The attenuation measurement shall be performed on an end-to-end, fiber-to-fiber basis using an optical loss test set.
 - e. The OTDR signature shall also be taken on a fiber-by-fiber basis and used to identify any fiber anomalies. These shall be recorded and evaluated to ensure that no potentially bad fiber or splice is placed in service initially or at a later date. The signature shall be saved (via photograph or other graphic record) for future reference.
 - f. The following fiber optic tests shall be performed prior to system and customer acceptance:
 - 1) After each splice is made, but before the splice case is closed, its loss shall be measured with an OTDR. Test requirements for a single mode fiber splice is less than or equal to 0.25 dB.
 - 2) After the installation of all of the cable is complete and all splices are made and tested, personnel shall perform the cable completion test. This consists of measuring the loss of each fiber path in both directions between fiber optic connectors in the patch panel. The loss measurements shall be made at the operation wavelengths being engineered and planned. Dual window fibers shall be tested at both the long and short wavelengths as specified by the design Specifications.

3.2 INSIDE PLANT CABLE INSTALLATION

A. Raceway Installation

1. Conduit

- a. Conduit provided for all communication wiring shall be color coded blue for identification. Minimum size for conduit is 1". Conduit runs shall have bushings at both ends and grounded at in accordance with the NEC.
- b. Conduit shall be metallic and run in the most direct route practical.
- c. Conduit runs of 100 feet or more require a pull box.
- d. Conduit runs containing more than two 90 degree bends, or a reverse (100 degree) bend require a pull box. Pull boxes are to be sized per the NEC 314.28 and cable manufacturer specifications.

- e. All offsets shall be rated as equivalent to a 90-degree bend.
- f. Conduit bends shall meet a standard of 10 times the outside diameter of conduit unless otherwise approved by the University.
- g. Conduits and equipment shall be independently supported. Do not suspend from water, steam or other piping or ducts.
- h. Secure all supporting methods by the following means:
 - 1) Toggle bolts in hollow masonry.
 - 2) Expansion bolts in concrete.
 - 3) Wood screws or bolts in wood.
 - 4) Machine screws or bolts in metal surfaces.
- i. Conduit support systems shall be securely and adequately installed to preclude movement of conduit and cable tray during cable pulling operations.
- j. In multi-level structures, the CER's shall be designed so they are stacked one above the other. A minimum of three 4 inch conduits shall connect the CER's. These conduits shall have bushings on both ends. Conduits in the CER below shall extend only far enough below the ceiling to permit installation of a bushing or to clear any obstruction that permits access to the conduit. In the CER above, this conduit shall extend a minimum of 3 inches above the finished floor, and a maximum of 5 inches. Conduits shall be placed a maximum of 2 inches away from the finished wall.
- k. Conduit entering CER spaces from station outlets shall penetrate the closet walls at a height above the plywood panels and extend only far enough to install bushings.
- l. After installation all conduits shall be:
 - 1) Clean, dry, and unobstructed.
 - 2) Covered for protection.
 - 3) Labeled for identification.
- m. Conduit runs for horizontal distribution cables, utilizing the trapeze hanger method to support the conduits, shall utilize threaded rods of not less than 3/8 inch diameter.
- n. Flexible conduit, Greenfield type, will not be permitted unless approved by the Information Technology Services (ITS) Plant Engineer.
- o. Only Wiremold NM2000BC or DS6000 raceway is to be used when station outlets are to be installed in surface mounted raceway. **Sharing wiremold with electricity is not permitted.** All surface mounted raceway designs are to be approved by the Information Technology Services (ITS) Plant Engineer.
- p. The systems furniture shall provide a communications wiring raceway separate from electrical cables. Raceway capacities shall be based on a 50 percent fill and allow for 25 percent growth.

- q. All raceway elements of the systems furniture and building connections shall be easily accessible so disruption to adjacent work areas is minimized when service is required.
2. Pull Boxes
- a. All pull boxes shall be sized according to NEC 314.28 and cable manufacturer specifications.
 - b. All pull boxes shall be placed in a straight section of conduit. Do not use boxes in lieu of a bend. If a box is used in lieu of a bend, it shall be replaced at no additional cost to the University.
 - c. Align the corresponding conduits at each end with each other.
 - d. All pull boxes shall be entirely accessible. Any water, vent, gas or steam pipes limiting access to a pull box shall be re-routed at no additional cost to the University.
 - e. All pull boxes shall be complete with covers of same gauge as boxes and secured to boxes with screws.
 - f. A hinged access panel shall be provided in the ceiling directly below all pull boxes placed above non-accessible ceilings.
 - g. All boxes shall be properly and adequately secured. The conduits entering the box shall not support them.
 - h. Secure all supporting methods by the following means:
 - 1) Toggle bolts in hollow masonry.
 - 2) Expansion bolts in concrete.
 - 3) Wood screws or bolts in wood.
 - 4) Machine screws or bolts in metal surfaces.
3. Cable Trays
- a. Station conduit requires a junction box to enter the cable tray.
 - b. Cable trays placed above ceilings shall have a 12 inch minimum access above and 18" on at least one side of the tray. In addition the cable tray is to be a minimum of 6" above the ceiling. No other utility may be routed through the cable tray.
 - c. The flexible cable tray system shall be only for communications cabling.
 - d. Support raceways on approved types of wall brackets or trapeze hangers. Plumbers perforated straps are not permitted as a means of support. **Center hung supports will not be allowed.** Cable trays shall be installed per the manufacturer's specifications.

- e. When pulling cables through conduits, cable trays and ducts that are supported by threaded rods and unistrut, they shall be braced to withstand the tensions used for pulling cable.
 - f. Brackets or hangers shall be manufactured by GS Metals, Unistrut, B-line, or as approved.
 - g. Secure all supporting methods by the following means:
 - 1) Toggle bolts in hollow masonry.
 - 2) Expansion bolts in concrete.
 - 3) Wood screws or bolts in wood.
 - 4) Machine screws or bolts in metal surfaces.
 - h. Cable tray support systems shall be securely and adequately installed to preclude movement of conduit and cable tray during cable pulling operations.
4. Communications Outlet Boxes
- a. The exact location of outlets and equipment shall be determined by the user and governed by structural conditions and obstructions, or other equipment items. When necessary, relocate outlets so that when fixtures or other devices are installed, they will be symmetrically located according to the room layout and will not interfere with other work or equipment. All station outlets shall be mounted to permit the vertical placement of faceplates.
 - b. Standard data outlets shall be fitted with a dual gang plaster ring, and wall mounted telephone outlets shall be fitted with a single gang plaster ring.
 - c. Outlets shall be serviced individually by a given conduit drop. Looping or "daisy chaining" of outlets is not acceptable.
 - d. Back-to-back outlets in the same wall, or "thru-wall" type boxes are not permitted. Offset all outlets shown on opposite sides of a common wall to minimize sound transmission.
 - e. Outlet boxes in finished walls or ceiling shall be fitted with appropriate covers, set to come flush with the finished surface. Sectional switch boxes or utility boxes are permitted where raceways are finished or otherwise concealed. Reasonable effort shall be taken to ensure plaster rings are level.
 - f. Unless otherwise noted, locate station outlets above finished floor to center line of boxes as follows:
 - 1) Standard telephone and data outlet - 1'-6" or at same height as adjacent duplex outlet.
 - 2) Wall mounted telephone outlet (standard) - 4'-6".
 - 3) Wall mounted outlets and public telephones (which persons who use wheelchairs can only access via a front approach) - 4'-0".

- g. Adjust heights of outlets in masonry walls so outlet box will be set in corner of block or brick and align with mortar joints. Outlet height so adjusted shall be consistent in one direction.
- h. Where outlets are installed in steel stud type systems, provide additional cross bracing and straps to make the outlet completely rigid prior to application of the wall facing material.
- i. Outlets placed above counters shall be installed 8 inches above the back splash. Mounting heights required for these outlets shall be coordinated by the Electrical Contractor per the Contract Documents.
- j. Unless otherwise noted, floor outlet boxes with "snap-in" modules designed for voice and data wiring systems shall be designed to accept Panduit Mini-Com module components to provide voice and data services in addition to extending commercial power. Floor boxes shall be a minimum size of 12 1/8" l x 12 1/8" w x 3 1/2" d. All floor boxes are to be approved by Information Technology Services (ITS) Plant Engineering.
- k. When using movable or systems furniture, it is recommended to provide communication services to this area by placing the voice/data jacks in an adjacent stud wall or using recessed floor ports. Placing jacks within the modular furniture is not advised.
- l. Systems furniture manufacturers shall provide either two 2-11/16 inch wide by 1-3/8 inch high openings or 1 single gang NEMA opening for every station outlet specified.
- m. Communications stations outlets located on both sides of a systems furniture partition shall be offset so they do not interfere with one another.

B. Grounding

- 1. All conduit and cable tray systems, supports, cabinets, equipment, etc., shall be properly grounded in accordance with the latest edition of the *National Electrical Code (NEC)*, ANSI/TIA/EIA-607, and all other applicable codes and regulations.
- 2. Provide all bonding wire and jumpers, grounding bushings, clamps, etc., required for complete grounding.
- 3. Route ground conductors to provide the shortest, most direct path to the ground electrode system.
- 4. All ground connections shall have clean contact surfaces, tinned and sweated while bolting.
- 5. Avoid splices in bonding or grounding conductors. If splices are required they shall be cad welded.
- 6. Provide a separate grounding conductor, securely grounded on each side of all conduit and cable trays that do not provide a continuous, metallic path. Size in accordance with the *National Electrical Code (NEC)*.

7. IDF protector frames shall be grounded by means of a 3/4 inch conduit (minimum) with an insulated #6 AWG (minimum) ground wire to the counterpoise ground system, measured at 5 ohms. The University allows no splices without prior approval.
8. Do not use a gas pipe as the grounding electrode.
9. Any grounding or bonding conductor that is run through a metallic conduit shall be bonded to the conduit on both ends.

C. Cable Installation

1. Copper

- a. Cable shall be installed per manufacture specifications.
- b. The maximum pulling tension for a 4 pair horizontal cable is 25 lb. Cables damaged by excessive pulling force shall be replaced at no additional cost to the University.
- c. The minimum bend radius a 4 pair horizontal cable is 1 inch.
- d. Do not walk or step on station cables. Do not run over cable with hand trucks or heavy equipment.
- e. All cables, wires and equipment shall be firmly anchored.
- f. Ty-rap cable ties shall not be used to support cables. They may be used for securing cables to hooks, etc.
- g. Fasteners and supports shall be adequate to support loads with ample safety factors.
- h. Plastic wire ties shall not be used to bundle or support Category 6 cables. Velcro wire wraps shall be used to prevent excessive crimping of the cables.
- i. All splicing shall be performed to industry standard practices.
- j. Splice cases in the IDF for incoming cable shall be mounted to backboards, unless otherwise indicated, using the appropriate hardware and supports.
- k. No splice cases shall be permitted in cable trays.

2. Fiber Optics

- a. Cable shall be installed per manufacture specifications.
- b. All cable shall be installed free of kinks. A kink is defined as a violation of the manufacturer's specified Minimum Bend Radius for each type of cable.
- c. Cable shall not be formed into a condition that causes the outside sheath to wrinkle.
- d. All necessary cable data including maximum pulling tensions, minimum bending radii, shall be obtained by the Communications Contractor from the cable manufacturer before any cable is pulled. Exceeding the recommended pulling tensions or bending radii is not permitted. Any cable placed that exceeds these

requirements shall be replaced by the Contractor at no additional cost to the University.

D. Cable Termination

1. Copper

- a. All terminating blocks, cables and terminals shall be marked to conform to the existing numbering system.
- b. A minimum of two (2) data jacks shall be provided for each outlet including.
- c. Two data jacks are required at all wireless access points.
- d. 1 telephone jack shall be installed for each wall mounted telephone location.
- e. Only modules with removable insulation displacement connectors (IDC's) for station cable termination are permitted. Cable shall be terminated per TIA 568-B wiring standard.
- f. When terminating Cat 6 a maximum of ½ inch of sheath can be removed at the jack and patch panel with twist remaining intact.

2. Fiber Optics

- a. Fiber optic cables with less than 48 fibers terminated at the building CERs shall utilize Panduit Fiber Interconnect Cabinet. Single mode fiber will be terminated with SC ultra-polished connectors (UPC) duplex connectors and adapter panels.
 - 1) Single Mode Adapter Panels Panduit
- b. Fiber optic cables with more than 48 strands of fiber shall be terminated at the building shall utilize Corning Fiber Optic Termination Housing model CCH-04U and Splice Housings model CSH-03U. Single mode fiber will be terminated with SC ultra-polished connectors (UPC) duplex connectors and adapter panels.
 - 1) Single Mode Adapter Panels Panduit

E. Cable Identification

1. Horizontal Cable Labeling

- a. Provide permanent, computer generated labels on both ends of every Horizontal Cable, Patch Cord and Work Area Equipment Cable.
- b. Example of horizontal wiring label: 1A-A001 1A=Equipment Room number, A=the patch panel, and 001= patch panel port.

2. Telecommunications Outlet Labeling

- a. Provide permanent, computer generated labels at the station faceplate.

3. Fiber Optic Cables

- a. Fiber optic riser cables shall be identified as to the type of fiber (single mode) and shall be clearly labeled at end of the cable and the terminating panel with the appropriate designation.
- b. An example of labeling shall be SMSSA, 1-12 for single mode cables.
 - 1) The first 2-4 characters identify the type of fiber.
 - 2) The next 2 characters (SS) remain constant.
 - 3) The next character represents the number of cables in alphanumeric order (A through Z).
 - 4) The numeric numbers represents the number of fibers within the cable.

F. Acceptance Testing

1. Copper cable testing

- a. Test all Category 6 horizontal cabling using a digital cable analyzer and certify that the system is complete and functional.
- b. A Level IIe or better test unit is required and must be updated to include the requirements of ANSI/TIA/EIA-568-B.
- c. The basic tests required are:
 - 1) Wire Map
 - 2) Length
 - 3) Attenuation
 - 4) NEXT (Near end crosstalk)
 - 5) Return Loss
 - 6) Propagation Delay
 - 7) Delay Skew
 - 8) PSNEXT (Power sum near-end crosstalk loss)
 - 9) PSELFET (Power sum equal level far-end crosstalk loss)
- d. Submit all test data to the Architect for review and approval.
- e. Spot test cabling in the presence of the Architect to verify the accuracy of the data submitted.
- f. Spot tests will be reflective of the test data submitted or the entire system will be retested in the presence of the Architect, and at the Contractor's expense.

END OF SECTION 270000

This section of the *UIS Facilities Standards* establishes minimum requirements only. It should not be used as a complete specification.

SECTION 2813 00 - ACCESS CONTROL

PART I - GENERAL

1.1 SUMMARY

1. The access control system shall be complete and functional.
2. Access control system will interface with existing S2 access control system network allowing for programming, control, and monitoring of the system.
3. Provide coordination to ensure that the system furnished includes integration of, or interfacing to all devices and systems.
4. Provide coordination to ensure that the system will integrate with existing campus wide access control system.
5. System will control locking devices for architectural style doors.
6. Provide programming that integrates control of devices indicated in the project documents.
7. Access control system will interface with handicap accessible doors. When the building is secured, a valid card read unlocks the door, then activates the paddle activating the door opener. Provide integration and coordination as required with door hardware supplier.
8. Access control will provide for group and individual remote release function.
 - a. Access control panels will interface with owner furnished LAN. Contactor shall coordinate all requirements of interfacing with LAN switch in the telecommunications closet, as well as address requirements for all devices residing on the LAN. All network switches required will be owner furnished and installed. Contractor is responsible for coordinating final connectivity, addressing, and V-LAN requirements.
 - (a) During programming the contractor will work with the Owner/User to define and schedule all aspects of the access control system.
9. Provide licensing of new control panels as required for number of controlled doors shown
- B. Provide a complete hard wired door access control system as specified herein and on the Drawings.

1.2 QUALITY ASSURANCE

- A. Manufacturer: The access control system shall be a single-source manufacturer such that the single vendor distributes, supports, warranties and services all components.
- B. Installer: The installing dealer must be a factory-authorized service and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturers system installation and programming. The installer shall retain the services of a formally-trained system administrator with expertise in Microsoft Windows operating systems.
- C. Registered S2 technician and Owner personnel shall certify all installations.
- D. All installations shall comply with the National Electric Code and UIS Department of Public Safety.

- E. All components shall be UL listed.

1.3 AS-BUILT DRAWINGS

- A. In addition to the requirements for record documents as specified elsewhere in these Standards, as-built drawings shall document the entire installed wiring system. This documentation shall include a detailed wiring diagram (in AutoCAD.dwg format) and be submitted in both electronic and hard copy formats.

1.4 WARRANTY

- A. Provide one-year warranty on all parts and labor.
- B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one-year warranty period.

1.5 SUBMITTALS

- A. Shop Drawings for equipment provided under this Section. In addition to complying with requirements of shop drawings as stated elsewhere in these Standards, shop drawings shall include the following:
 1. AutoCAD drawings and load calculations for review and approval.
 2. Door contact shop drawings and installation details prior to installation for approval by Owner.
 3. Mechanical and electrical notes and construction details for each device.
 4. Interconnection diagrams showing a detail of each device and interconnect wiring between devices. Block diagrams involving cross-referencing to catalog specification sheets will not be acceptable.
 5. Catalog literature with performance specifications, which indicate compliance to the specifications herein.
 6. Complete instruction manuals, service manuals, parts lists, and current list of local manufacturer approved service centers.
 7. System provider/installer shall provide all additional information or demonstrations required by the Owner and AE to demonstrate conformance with the specifications herein.
Demonstrations shall be at a time and location and in a manner chosen by the Owner and AE.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. The access control system is sole source specified as S2.
- B. Substitutions will not be allowed.

2.2 ACCESS CONTROL PANEL

- A. Specifications
 1. Network Node
 - a. Support up to seven application blades
 - b. Supplied with 12 VDC at a minimum of 3 amps.
 - c. On board storage of up to 20,000 credentials for access control decisions and up to 27,000 records of logged system events.
 - d. Communication shall be encrypted (SSL 128-bit) and authenticated (SHA-1).
 2. Access Control Blade

- a. Support up to two readers, four supervised inputs, and four relay outputs.
 - b. Support input supervision types including normally-open, and normally closed circuits, and zero, one or two resistor configurations.
 - c. Both normally-open and normally closed circuit output devices are supported. Relay outputs shall support any output devices that operate on 30 Volt DC or AC, 2.5 Amps inductive or 5.0 Amp non-inductive.
3. Alarm Input Blade
- a. Support input supervision types including normally open and normally closed circuits, and zero, one, or two resistor configurations.
 - b. Support up to eight alarm inputs.
4. Relay Output Blade
- a. Support up to eight relay outputs.
 - b. Both normally-open and normally closed circuit output devices are supported. Relay outputs shall support any output devices that operate on 30 Volt DC or AC, 2.5 Amps inductive or 5.0 Amp non-inductive.
5. System Enclosure
- a. Solid state system enclosure
 - b. Contains one Controller blade and from two to seven application blades.
 - c. Keyed lock
 - d. Tamper switch
 - e. 100-24 VAC at 50-60 Hz.
- B. Acceptable Manufacturers
- 1. S2 Network Node. Provide two network nodes. One located in Storage 160, a second located in Telecom A/V 211. Each node to be equipped with quantity of blades sufficient for number of controlled doors fed from that closet. Provide licensing of new control panels as required for number of controlled doors shown.
- C. Specifications
- 1. Encoding: 75 BPI, Aiken Biphase
 - 2. Read Speed: 3-50 inches per second
 - 3. Case: Aluminum alloy
 - 4. Connection: 6 conductor cable with connector
 - 5. Voltage: +5 Vdc or +12 Vdc
 - 6. Current: 20 mill amperes
 - 7. Wiring: 500' max
 - 8. Data Output: data 1/data 0 (Wiegand pulses) or clock and data (magnetic)
 - 9. LED's: Upper: Red, Lower: Green, LED Control single line buzzer.
- D. Approved Manufacturer
- 1. Mercury Security MS-MR1012 card reader. Provide WP-10 wall plate adapter for mounting to single gang back boxes. Readers installed on exterior of building shall be ordered with – OW weather proof option and be equipped with WS-10 weather shield.

Coordinate mounting and routing of cable for readers installed in aluminum framing of glass curtain wall.

PART 3 - EXECUTION

A. INSTALLATION

1. All system programming shall be done at the contractor's facility prior to installation on site.
2. Qualified personnel shall install the System in strict compliance with manufacturer's instructions.
3. Wiring shall be color coded, uniform and in accordance with national electric codes and manufacturer's instructions.
4. Equipment shall be firmly secured, plumb and level.
5. All cable runs to the main equipment rack shall be tagged and identified.
6. Coordinate all work with other trades and Contractors.
7. Grounding of cables and peripheral equipment shall be installed per manufacturer's direction to eliminate noise induction and achieve optimum system performance.

B. SYSTEM OPERATIONAL SUPPORT

1. As part of the shop drawing submittal, the Contractor is required to submit a written report outlining the project specific functions and operational procedures of the access control system. This report will include the following:
 - a. The Contractor shall present proposed operational procedures for every function specified in Contract Documents or recognized as industry standard or convention for an access control system. All operational procedure possibilities will be presented to the Owner/User & Architect by the Contractor.
 - b. The Contractor shall address integration of the components and subsystems making up the control system when presenting the proposed operational procedures.
 - c. As a minimum the report shall contain the following:
 - (a) A procedural description of each and every control function.
 - (b) A procedural description of all administrative functions available to supervisory and maintenance personnel (e.g. log in code maintenance, alarm time zone programming).
 - (c) A preliminary technical description of how each function will be accomplished.

C. SOFTWARE SUPPORT

1. Prior to programming of the system, the Contractor shall request, in writing, scheduling of a system programming coordination meeting. This meeting is to take place during the product procurement, after submittals have been approved. A proposed agenda shall be included with the request.
2. The purpose of the coordination meeting is to define the project specific functions and operational procedures of the control system with the Owner/User and Architect.

3. The Contractor shall present proposed operational procedures for every function specified in Contract Documents or recognized as industry standard or convention. The Contractor will present all operational procedure possibilities to the Owner/User & Architect.
4. The Contractor shall address integration of the components and subsystems making up the control system when presenting the proposed operational procedures.
5. The contractor shall refrain from any programming of the Access Control/Intrusion Detection system until after the Architect has reviewed and approved the programming report.
6. The Owner/User and Architect reserve the right to change programming of the Access Control/Intrusion Detection System after installation and prior to final acceptance.

D. SYSTEM INITIALIZING AND PROGRAMMING

1. Coordinate installation of software on owner furnished workstations.
2. All programming shall occur in the Contractor's shop prior to installation on site.
3. The System shall be turned on and adjustment made to meet requirements of the specification and on-site conditions.
4. The System shall be programmed to function as specified.
5. Any special programming shall be documented and a written copy given to the Owner/User.
6. Coordinate integration of other electronic systems as called for in the contract documents.

E. SYSTEM TEST PROCEDURES

1. The System shall be completely tested to assure that all components are hooked up and in working order. Inspect system for defects. Correct all causes of such defects. If the cause is outside of the scope of the Division 28 series scope of work, promptly notify the Architect in writing, indicating the cause of the defect and suggested corrective procedures.
2. The contractor is to verify the system is communicating with all controlled devices.
3. Test 120VAC power equipment and hardware internal to all equipment racks. Test all conductors for shorts, opens, and polarity.
4. Verify operation of battery backup. Test by removing power from system.
5. Verify all field wiring is free of shorts and opens prior to termination of head end electronics.
6. Provide written documentation showing all test results.
7. The System shall be final tested in the presence of the Architect. Contractor is to provide all required testing equipment.

F. TRAINING

1. Contractor is responsible for providing operational and maintenance training applicable to the entire control system. Training is to include, but not belimited to the following-
 - a. Review all O+M manuals with Owner/Users representatives present for training.

- b. Perform a tour of the entire facility. During the tour the trainer shall point out all control equipment and provide a brief description of its purpose and use. This is to include but not be limited to control panels (graphic and pushbutton), all control system hardware, and devices controlled.
- c. Typical of keypadpanels-
 - (a) Demonstrate basic functionality of panel.
 - (b) Demonstrate devices/systems controlled by panel.
 - (c) Review control functions of all buttons.
- d. Explain functionality and operation of controlled entrances

END OF SECTION 281300

This section of the *UIS Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 283000 - FIRE AND SMOKE DETECTION SYSTEM

PART I - GENERAL

1.1 RELATED SECTIONS

- A. 23-09-13- *Instrumentation And Control Devices For HVAC*
- B. 26-05-33- *Raceways And Conduits*
- C. 26-05-19- *Conductors And Cable*
- D. 26-80-00- *Elevator Electrical Requirements*

1.2 SUMMARY

- A. Work shall include, but not be limited to the following:
 - 1. Fire alarm panels: JCI/Simplex 4100 ES. Voice system shall be designed to meet the building needs.
 - 2. Automatic smoke and heat detection.
 - 3. Manual alarm initiation.
 - 4. Air handling unit (AHU) controls to integrate AHU into the fire alarm system operation (where applicable).
 - 5. Monitor of sprinkler water flow and supervisory alarm switches.
 - 6. Alarm annunciation.
 - 7. Elevator recall.
 - 8. Elevator machine room sprinkler system and equipment shutdown.
 - 9. Stairwell pressurization.
 - 10. Smoke removal and smoke exhaust.
 - 11. 4100 ES panel microphone shall integrate with the building Public Address (PA) system (where applicable).
- B. No Work shall be performed until the Shop Drawings and product data have been approved by Owner. This will require early processing of all submittals. The Contractor is solely liable for any Work performed or material purchases made prior to this approval.
- C. The Contractor shall be responsible for the zoning system to comply with all applicable codes. For renovation projects the zoning system shall resemble existing zoning schemes in the building being modified. The Contractor shall be responsible for the proper location of all devices to comply with applicable codes.
- D. Each system shall be electrically supervised, connected, tested and proven to be in operating order.

1.3 TEMPORARY PROTECTION

- A. Where modifications to existing fire alarm devices or equipment cause Interim Life Safety Measures to remain in place for a period of time exceeding 48 hours, temporary protection shall be provided to the affected area.
- B. Temporary protection shall comply with the requirements listed in this Section.

1.4 QUALITY ASSURANCE

- A. Compliance: This installation shall be made in accordance with the Drawings, Specification and the following:
 - 1. National Electrical Code, Article 760, NFPA 70.
 - 2. National Fire Protection Association, *National Fire Alarm Code, Standard No. 72*.
 - 3. National Fire Protection Association, *Installation of Sprinkler Systems, Standard No. 13*.
 - 4. Local Codes and Authorities having jurisdiction.
- B. Shielding Conductors: Wiring requirements for shielding certain conductors from others or routing in separate raceways shall be as recommended by the manufacturer's documentation.
- C. UL Listed: The system, including all components, shall be listed by Underwriters Laboratories Inc. for use as a fire protective signaling system.
- D. Registration: The fire alarm Supplier and Installer shall be registered with the State of Illinois Department of Registration and Education as a Private Alarm Contracting Agency. Proof of registration shall be submitted with the shop drawings.

1.5 SPECIAL CONDITIONS

- A. Local Representation: The manufacturer or his authorized distributor shall confirm that within reasonable distance of the job site, within 3 hours of travel time, there is an established agency which stocks a full complement of parts and offers service during normal working hours on all equipment to be furnished, and that the agency will supply parts without delay.
- B. New Materials: All material and equipment shall be new and unused.
- C. Communication with NCC/WAN in Public Safety Building: Communication with the NCC/WAN at the Police/Fire Dispatch Center in the Public Safety Building requires a twisted pair between the NCC/WAN at the Police/Fire Dispatch Center in the Public Safety Building and the XLS-V control panel at the building.
- D. Latest Revision: All hardware and software furnished shall be the manufacturer's latest revision or product version, at the time of final acceptance.
- E. Continuous Operation: All individual components and composite systems shall be designed for continuous operation without undue heating or change in rated values, and shall be properly fused or protected.

1.6 WARRANTY

- A. Contractor Warranty: All equipment and systems shall be warranted by the Contractor for a period of 1 year following acceptance. The warranty shall include parts, labor, prompt field service, pickup and delivery.
- B. Manufacturer Warranty: In addition to the Contractor's warranty, the manufacturer, Simplex, shall provide 1 additional year parts warranty.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION AND FUNCTION

- A. System Includes: The automatic fire detection and alarm system shall consist of the main control panel, initiation devices, voice system, audible-visual alarms, suppression systems supervision, food service dry chemical systems supervision, sprinkler waterflow, magnetic door holders, gate valve supervisory switches, and a working communication link with the Campus NCC/WAN located at the Police/Fire Dispatch Center in the Public Safety Building. The 4100 ES system shall be capable of being expanded at any time up to the predetermined maximum capacity of the system.

- B. Supervision and Control: The system shall be capable of operating with both addressable and non-addressable manual, ionization, thermal, infrared and photoelectric detecting devices, water-flow switches and supervisory switches. The control panel shall provide power, annunciation, supervision and control for the fire detection and alarm system. The system shall be designed such that alarm indications override trouble conditions. The panel shall be capable of measuring the sensitivity of the addressable ionization and photoelectric detectors connected to it. External loop circuit supervision shall not require additional wires other than the pair used for detection of alarm. Only 2 wires shall be used from the control panel to each loop of initiating devices and 2 wires for the audible devices. These 2 wires shall provide both supervision and alarm signals. There shall be no loss of supervision for class "B" wired addressable devices. Class "A" supervision may be provided by adding an additional pair of wires.
- C. System Function: The system shall function as follows when any area or duct detector, manual station or waterflow switch operates:
 - 1. Sound required audible devices as shown on the schedule.
 - 2. Automatically transmit an alarm indication to the NCC/WAN Control Center at the Police/Fire Dispatch Center in the Public Safety Building.
 - 3. Display individual detector and/or zone number on alphanumeric display with the user defined message.
 - 4. Light an indicating lamp on the device initiating the alarm.
 - 5. Initiate the sequence of operations specified for that device; e.g., alarm, local, general, reporting, trouble reporting only. Alarm shall have priority over trouble. Trouble conditions shall be reported to include the device number, location and type of trouble.
 - 6. A suppression system device shall not be used to replace an area detector as an alarm initiation device.
- D. Shutdown of the HVAC system and operation of dampers is only to be initiated by duct detectors or smoke detectors.
- E. The fire alarm system is of the addressable initiating device type. Each device monitored for alarm, trouble, or other purposes shall have a unique address. Monitoring or controlling more than 1 device with only 1 address is not permitted.

2.2 CONTROL EQUIPMENT

- A. Panel Construction and Capacity: The control panel shall provide power, annunciation, supervision and control for the detection and alarm system. The control panel shall be modular in construction, and contain all modules necessary to operate as specified and indicated. The system shall be capable of reading and displaying at the control panel, the sensitivity of remote addressable ionization and photoelectric detection devices. Individual addressable detection device alarm threshold shall remain 100 percent operational and capable of responding to an alarm condition while in the routine maintenance mode. Addressable detection devices shall be individually identified by the system and any quantity of addressable detection devices shall be in alarm at any time up to the total number connected to the system.
- B. Addressable and Non-Addressable: The control panel shall be capable of supporting non-addressable as well as addressable detection devices.
- C. The control panel shall be provided with modem board for transmission of system serial data to the campus NCC/WAN.
- D. Permanent Records: The control panel shall support a connection to the NCC/WAN. The connection to the NCC/WAN shall be used for permanent records of the fire alarm system's status and detector chamber voltages, and shall also be capable of system control as configured.
- E. Initiating Circuits: Class "B" wiring only.

- F. DC Audible and Visual Devices: An output circuit for operation of DC audible and visual devices, leased line or tie, or Clean Agent release shall be provided by a Siemens Division programmable signal module. This module shall be system interconnected by a card edge connector, and shall be operable by the XLSV control unit. Upon command by the 4100 ES control unit, the output circuits will respond as configured. All signal circuits shall require and be fitted with an end of line device.
- G. AHU and Elevator Control: For control of air handling units and elevators there shall be provided a Siemens Division programmable supplementary relay module. The module shall be system interconnected by a card edge connector and shall be operable by the 4100 ES control unit or manually. It shall contain 4 independent relays, fitted with form "C" contacts, rated at 120 VAC, 2 AMPS resistive or a remote located addressable interface with relay module, model HTRI could be utilized. Coordinate with Building Automation System (BAS) documents and provide as required for the indicated control.
- H. Elevator Recall Subfunction: An elevator recall subfunction shall be provided. Elevators shall be recalled only when elevator lobby or machine room detectors are activated to alarm state. No other detector shall activate elevator recall.

2.3 ALARM INITIATING DEVICES

- A. Photo and Thermal Detectors: All addressable and non-addressable photo, ionization, and thermal detectors shall be capable of being intermixed on the same control panel. All detection devices shall contain an integral alarm LED. All addressable detectors shall be individually identifiable from the control panel. Non-addressable detectors, where permitted, shall be identifiable by zone.
- B. Addressable Thermal Detectors: The addressable thermal detectors shall be of the rate compensated fixed temperature type and shall be listed by Underwriters Laboratories Inc. The addressable thermal detectors shall be individually annunciated on the control panel. The addressable thermal detectors shall contain an integral alarm lamp.
- C. Duct Detectors
 - 1. Detector Mounting: The duct detectors shall be listed by Underwriter's Laboratories, Inc. The duct detectors shall operate on a cross-sectional air sampling principle to overcome stratification and the skin effect. The duct detector shall consist of a photo detector mounted in a duct detector housing with sampling tubes installed per manufacturer instructions in accordance with NFPA 72.

2.4 ALARM INDICATING DEVICES

- A. Audible/Visual Devices: Shall be the same as the fire alarm panel manufacturer.
- B. Provide exterior rated strobe devices for building.

2.5 MAGNETIC DOOR HOLDERS

- A. Magnetic Door Holder Devices: Magnetic door holders shall be dual rated for 120 Volt and 24 Volt DC. Door holders shall be flush mounted and have an adjustable hold force of 10 to 40 pounds at 85 percent of rated power supply. If wired for 120 Volt AC, the power shall come from a local emergency power panel. If wired for 24 Volt DC the power is to come from the FACP or nearest PAD. Simplex shall manufacture the magnetic door holder devices.

2.6 ELEVATOR RELATED DETECTION AND ALARM REQUIREMENTS

- A. General
 - 1. Smoke Detectors are required in all elevator lobbies and elevator machine rooms. Only the smoke detectors located in elevator lobbies and machine rooms shall affect the specific elevator in the building. ASME A17.1, NFPA 72, 3-9.3
 - 2. Smoke and heat detectors are never required in elevator pits and shall not be installed in them.

3. Smoke detectors are not required in hoist way overheads, and shall not be installed in them.
4. Hoistway Venting: All machine room and lobby smoke detectors shall activate a fire alarm addressable relay to open the smoke vent if venting is present at the top of the hoistway.
5. If a sprinkler head is present in the elevator hoistway overhead, a heat detector with associated shunt trip shall be provided within 2' of the sprinkler head. A sprinkler is typically only allowed in elevator hoistways in older existing buildings due to fire rating requirements of shaft and elevator cab. (ASME A17.1)

B. Fireman's Service Phase 1 and Phase 2:

1. Programming: Smoke detectors in elevator lobbies on floors other than the designated floor and the elevator machine room; shall be programmed upon activation to provide 1 contact closure that shall be input to the elevator controller that shall place the elevator in Fireman's Service Phase I. This shall be accomplished by outputs of the smoke detectors on all floors except for the designated floor and elevator machine room.
2. Designated Floor Programming: The designated floor elevator lobby smoke detector shall be programmed upon activation to provide contact closure that shall be input to the elevator that shall place the elevator in Fireman's Service Phase 1 alternate floor.
3. Elevator Recall Subfunctions: The elevator recall subfunctions shall operate only when elevator lobby or machine room initiating devices are activated to alarm state. No other detectors or initiating devices shall activate any of the elevator recall subfunctions.
4. Elevator Machine room smoke detector shall also activate a fire alarm addressable relay for the "Fireman's Hat" flashing light. Service visual signal of the elevator controls as is required by ASME A17.1
5. Elevator Supplier: The programming of all elevator subfunctions shall be coordinated with the elevator supplier to ensure proper operation.
6. New and Remodel Projects: Requirements of this Section shall apply to both new construction and remodel Projects.

C. Shunt Trip Circuit Breaker/Fire Alarm System/Fire Protection Sprinkler Control

1. Hoistways and Elevator Equipment Rooms: If hoistways and elevator equipment rooms are protected by fire protection sprinkler systems, they shall each be equipped with a heat detector and shunt trip circuit breaker feeding electrical power to the elevator equipment.
2. Heat Detector Alarm: When the heat detector goes into alarm it shall signal the shunt trip circuit breaker to trip. The temperature setpoint of the heat detector shall be less than the temperature setpoint of the fire protection sprinkler heads in the space. A heat detector is required to be located within 24" of the sprinkler. NFPA heat detector is not required in the elevator pit even if there is a sprinkler present provided that the sprinkler is installed within 24" of pit floor.
3. Smoke Detectors in Elevator Lobbies: This control scheme shall operate with the smoke detectors in the elevator lobbies and their Fireman's Service, Phases 1 and 2 control scheme.
4. Elevator Shunt Trip: The shunt trip power shall be supplied from a fire alarm system that has a UPS/battery backup, or any power source used in conjunction with a power monitor.
5. Power Monitor: The shunt trip fire alarm addressable relay shall monitor the shunt trip power monitor, via its supervisory switch.

2.7 FIRE PROTECTION SPRINKLER SYSTEM INTERFACE

- A. Monitor Sprinkler System: The fire alarm system shall monitor the sprinkler system as described below.

- B. Monitor Each Flow Switch: Provide an alarm causing addressable interface module to monitor each flow switch. Upon flow a system alarm shall be generated that shall activate the building evacuation signals, trip the master box, and transmit an alarm message to the NCC/WAN located at the Public Safety Building. This shall include each flow switch in the system, including the main system flow switch and zone flow switches on each section of branch piping. Each flow switch shall be monitored by an addressable interface module with a unique address. The system shall display a unique alarm message for each flow switch monitored.
- C. Monitor Each Shutoff Valve: Provide a trouble causing addressable interface module to monitor each shutoff valve in the system. Upon sensing valve position other than full open a system trouble shall be generated that shall transmit a trouble message to the NCC/WAN located at the Public Safety Building. All system valves shall be monitored including water supply valves, sectional control valves and all other valves in supply piping to sprinklers. Each valve shall be monitored by an addressable interface module with a unique address. The system shall display a unique address and unique trouble message for each valve.
- D. Monitor Fire Pump: Provide a supervisory causing addressable interface module to monitor the operation (pump run) of the fire pump. This alarm shall transmit a unique alarm message to the NCC/WAN located at the Public Safety Building. A fire pump run alarm *shall not* activate the system audio visual evacuation devices; activate the subfunctions such as fan shutdown an elevator recall; and trip the master box.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation of fire alarm system shall not be done in conflict with manufacturer requirements.
- B. Panels: Control and other panels shall be mounted with sufficient clearance for observation and testing. Fire alarm control panel shall not be installed where it could be exposed to excessive heat, moisture, or drastic temperature change. Fire alarm control panel shall either be located at the building entrance, or there shall be a remote annunciator located at the building entrance. All fire alarm junction boxes shall be clearly marked, by painting covers bright red, for easy identification.
- C. Wiring: All wiring shall be in metallic red color conduit, EMT or other approved methods. Flexible connectors shall be used for all devices mounted in suspended lay-in ceiling panels. All conduit, mounting boxes, junction boxes and panels shall be securely hung and fastened with appropriate fittings to ensure positive grounding throughout the entire system. All wiring shall be color coded and labeled at each junction box and device. All wiring shall be per NEC and manufacturer direction, checked and tested to ensure that there are no grounds, opens or shorts. Initiating circuit conductors shall be no smaller than size 18AWG. Notification circuit conductors shall be no smaller than size 14AWG.
- D. Labeling: No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than 1 wire shall be labeled on each end, in all junction boxes, and at each device with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc., shall be clearly labeled on all equipment panels.
- E. Audible Suppression Devices: Provide, as required, audible suppression devices for interference-free and properly operating system and that both audible and multiplex wiring be run in same raceway.

3.2 TEST AND REPORTS

- A. Electrical And Mechanical Tests: The Contractor shall perform all electrical and mechanical tests required by the equipment manufacturer's standard checkout procedure.
- B. 3 Items Required Prior to Test: At the time the system is tested, the Contractor shall supply the following items to the Owner before the test is started. If the following three items are not supplied, the tests shall *not* be allowed to begin.
 - 1. A copy of the Simplex Custom Software Generator printout.
 - 2. Drawings showing the floor plan of the building, device locations, and device addresses.
 - 3. A copy of the system software, all necessary communications software, all applicable client licenses, and demonstration that the system can be accessed by an Owner portable computer.
- C. Test Entire System: Final testing of the system shall not occur until the entire system is 100 percent complete and fully functioning. In the event that phased construction schedules require partial system operation, portions of the system may be tested. However, the entire system must be operating and fully functional before final testing, final acceptance and substantial completion shall be allowed to occur.
- D. Smoke and Heat Detection Systems Demonstration: The completed smoke and heat detection systems shall be demonstrated to ensure their proper operation. This demonstration shall consist of activating the installed smoke detectors with U. L. listed test smoke, by U. L. approved methods. Heat detectors shall be demonstrated by activation with heat. Also, all interfaces with fans, elevators, or any other building systems shall be operated to demonstrate their correct installation. The test shall include accessing the system on an Owner computer. The Contractor shall furnish all system passwords, communication software, and system software to demonstrate. The software and passwords shall remain with the Owner for use in the continuing operation and maintenance of the system.
- E. Coordination with Elevator Final Inspection: All fire detection related items associated with the building including, but not limited to, smoke and heat detectors, main line shunt trips, hoistway damper and all devices interfaced with these devices associated with the fire detection system shall be pre-tested and found to be completely functional before a site inspection test is scheduled with the elevator contractor, state elevator inspector and the Owner. Failure to pre-test may result in actions allowed by the contract documents.
- F. Report: The report shall include:
 - 1. A complete list of equipment installed and wired.
 - 2. Indication that all equipment is properly installed and functions and conforms to these Specifications.
 - 3. Tests of each individual zone or for each individual device as applicable.
 - 4. Voltage (sensitivity) settings for each ionization detector as measured in place with the HVAC system operating.
 - 5. Response time on thermostats and flame detectors (if used).
 - 6. Technician's name, certificate number and date.
 - 7. Proof of certification of the system in accordance with NPPA 72.
- G. Final Testing: Final tests and inspection shall be held in the presence of AE and Owner personnel and to their satisfaction. The Contractor shall supply personnel and required auxiliary equipment for this test without additional cost. Any problems identified during system testing shall be corrected by reprogramming the 4100 ES system. After the reprogramming is complete, the Contractor shall submit the printout used for the subject reprogramming to the Owner.

- H. Closeout Submittals: After completion of all the tests and adjustments listed above, the Contractor shall submit the following information to the AE and the Owner:
1. As-built" conduit layout diagrams including wire color code and/or tag number.
 2. Complete "as-built" wiring diagrams.
 3. Detailed catalog data on all installed system components.
 4. Copy of the test report.
 5. A copy of the Simplex Custom Software Generator printout.
 6. Drawings showing the floor plan of the building, device locations, and device addresses.
 7. A copy of the system software, all necessary communications software, all applicable client licenses, and demonstration that the system can be accessed by an Owner portable computer.
- I. Operating and Maintenance Manual: Comply with all requirements listed in *Section 01 78 23 – Operation and Maintenance Data*. Before final acceptance of Work, the Contractor shall deliver 3 copies of a composite *Operating and Shop Maintenance Manual*. **If this is a Housing related project, 4 copies are required.** Each manual shall contain a statement of guarantee including date of termination and name and phone number of the person to be called in the event of equipment failure, including individual factory issued manuals containing all technical information on each piece of equipment installed. In the event such manuals are not obtainable from the factory it shall be the responsibility of the Contractor to compile and include them.
- J. 90 Day Verification: Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a 90-day test period without any unwarranted alarms. Should an unwarranted alarm occur, the Contractor shall readjust or replace the detector(s) and begin another 90-day test period. As required by the AE, the Contractor shall recheck the detectors using the fire test after each readjustment or replacement of detector. This test shall not start until the Owner has obtained beneficial use of the building under tests.

3.3 TRAINING

- A. Training: Provide three, 3-hour training sessions, with 1 session per day for 3 consecutive days, for campus Fire Department affiliates. Provide one 4-hour session of training in operation and maintenance. Training times indicated are actual times exclusive of travel.

END OF SECTION 283000

This section of the *U I S Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.

SECTION 311000 – SITE CLEARING**PART 1 – GENERAL**

1.1 RELATED DOCUMENTS

- A. Clear site of plant life and grass.
- B. Remove:
 - 1. Trees and shrubs where indicated.
 - 2. Root system of trees and shrubs.
 - 3. Surface debris.
 - 4. Vegetation.
- C. Perform clearing and grubbing operations.
- D. Removal of existing pavement, curbs and gutters and sidewalks.
- E. Protect benchmarks; repair damage to all areas outside contract limits to match specified new work.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 024100 Demolition
 - 2. Section 312316 Excavation
 - 3. Section 312500 Erosion and Sedimentation Control (with SWPPP)

1.3 REGULATORY REQUIREMENTS

- A. Conform to all applicable local, state, and federal codes for disposal of debris.
- B. Coordinate all site clearing work with the utility companies.

1.4 REFERENCES

- A. Conform to the applicable portions of Section 201, 440 and 501 of the Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, including all Supplemental Specifications and Recurring Special Provisions.

1.5 PROJECT CONDITIONS

- A. Conduct removals to minimize interference with adjacent building areas. Maintain and protect egress and access at all times.
- B. Provide, erect and maintain temporary traffic control and security devices in

accordance with the standard details and drawings included in the contract documents.

- C. Do not close or obstruct roadways and sidewalks without permits and Owner approval.
- D. Accept premises as found. Neither Owner, nor Engineer assumes responsibility for condition of areas or continuation of areas in condition existing at or after date of bidding documents.

1.6 SUBMITTALS (RESERVED)

PART 2 – PRODUCTS (RESERVED)

PART 3 – EXECUTION

3.1 CLEARING

- A. Clear designated areas for access to site and execution of work.
- B. Remove designated trees and shrubs, grass, weeds and other vegetation. Grub out stumps, roots, rocks, and obstructions which interfere with installation of new work.
- C. Clear undergrowth and deadwood, without disturbing subsoil.

3.2 PROTECTION

- A. Protect plant growth and features remaining for final landscaping.
- B. Protect benchmarks and existing work from damage or displacement.
- C. Maintain designated site access for vehicle and pedestrian traffic.
- D. Protect existing active utility lines during construction.
- E. Utility lines encountered during construction that are not scheduled to be removed must be protected, relocated, or scaled and capped by appropriate trades having jurisdiction.
- F. Protect all existing items not indicated to be removed.

3.3 REMOVAL

- A. Remove all waste materials from the Owner's property and legally dispose of same.
- B. All topsoil shall be stockpiled onsite or at a location as approved by the Owner. Any excess topsoil shall be returned to the Owner at completion of the project. The General Contractor shall coordinate the location of topsoil stockpiles with the UIS Director of Construction.

- C. Do not store debris, remove as it accumulates. If Contractor fails to remove debris promptly, the Engineer reserves the right to cause same to be removed at Contractor's expense. Debris may not be burned or buried on the site.
- D. Provide all measures of protection required by state authorities, regulations, and laws for protection of surrounding property, sidewalks, curbs, the public and all employees during removal operations. Measures taken, including sidewalks, sheds (if required), barricades, warning lights and signs, and rubbish chute (if required), shall be in strict accordance with the American Standard Building Construction A10-2-1944 and all applicable state and federal laws. Provide all protection as required by codes having jurisdiction and maintain until no longer necessary.

3.4 CLEAN UP

- A. Upon completion of work remove tools, materials, apparatus, debris and rubbish of every sort. Leave premises clean, neat and orderly.

END OF SECTION 311000

SECTION 31 2219 – FINISH GRADING

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. Provide imported topsoil if needed
 - 2. Excavate and backfill planting areas
 - 3. Spread topsoil

1.3 DEFINITIONS

- A. none

1.4 ACTION SUBMITTALS

- A. Materials
 - 1. Location and representative ½ cu.ft. sample of topsoil for approval.
- B. Equipment
 - 1. List of proposed equipment to be used. Equipment must avoid excess soil compaction.

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years' experience in similar work. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor is responsible to protect and avoid all existing above ground and underground utilities during construction operations. Repair of any utilities damaged by installation shall be the responsibility of the Contractor.
- C. Contractor is responsible to protect all existing conditions including structures, pavement and plant material from damage during project installation and maintenance. Any damages occurring are the responsibility of the Contractor to replace, repair or compensate Owner for damages.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Topsoil

1. Loamy soil from the A horizon soil profile of local prairie-type soils.
2. Imported to the site if on-site topsoil not available.
3. Organic content between 8 and 10 percent.
4. Free from roots, sticks, weeds, stones, etc. larger than 1 inch in dimension.
5. Entirely free of foreign material including construction waste, litter, and contaminating products.
6. At least 90 percent must pass the 2.00 mm sieve.
7. pH between 6.0 and 8.0.

PART 3 – EXECUTION

3.1 SCHEDULE OF WORK

A. Execution

1. When subsoil grade is approved by Owner's Representative and all foreign construction materials have been removed from the site.
2. When ground is not frozen, and temperatures are consistently above freezing.
3. When soil is relatively dry and friable to avoid clodding and compaction.

3.2 EXCAVATION AND TOPSOIL BACKFILL FOR PLANTS

A. Operations

1. Excavate for trees, shrubs, and plant beds to dimensions shown on project plans.
2. Test excavated area for water percolation. If beds do not adequately percolate as determined by the Landscape Architect, auger hole below the excavation to a depth determined necessary and backfill with pea gravel as shown on plan.
3. Back fill with approved topsoil in 12" lifts compacting moderately to 86-90% compaction.
4. Dispose of excavated material off the site, if not meeting topsoil standards.

3.3 TOP SOILING

A. Subsoil Preparation

1. Till subsoil to a minimum depth of 4".
2. Remove all roots, sticks, weeds, stones, etc. larger than 1 inch in dimension.
3. Remove all foreign material including construction waste, litter, and contaminating products.
4. Make any necessary grade adjustments
5. Till to a uniform 4" depth.

B. Depositing Topsoil

1. Deposit approved topsoil on the site.
2. Spread with light weight, lawn-scale equipment to avoid excess compaction of subsoil and topsoil.
3. Spread topsoil along improvements such as curbs, sidewalks, and fences with hand tools to avoid damage to the improvements.
4. All areas for seeding to have a minimum 12 inches of topsoil.
5. Soil clods to be no greater than 2" in any dimension.

C. Finish Grading

1. Finish to lines and grades shown on the plans.
2. Surfaces to be smooth with no rises or wrinkles.
3. All areas are to drain with slope away from structures and pavement unless shown otherwise.
4. Grade to meet the elevations of surrounding pavement.
5. Remove all roots, sticks, weeds, stones, etc. larger than 1 inch in dimension. Dispose of off-site.
6. Remove all foreign material including construction waste, litter, and contaminating products. Dispose of off-site.
7. Leave site in a smooth, stable condition. Roll any powdered soils to stabilize.
8. Final compaction to be 86-90%.

END OF SECTION 31 2219

SECTION 312316 – EXCAVATION**PART 1 – GENERAL**

1.1 WORK INCLUDES

- A. Excavating for sewers, pavements, sidewalks, curbs and gutter and incidental work.
- B. Removal and off-site satisfactory disposal of unstable and unsuitable materials.

1.2 RELATED WORK (RESERVED)

1.3 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Sections 202 and 502 of the Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, latest edition, including all Supplemental Specifications and Recurring Special Provisions.
- B. Prior to the commencement of construction, the Contractor shall be aware of, and become familiar with applicable local, state and federal safety regulations, including the current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successor regulations.
- C. Additionally, the Contractor shall be aware that slope height, slope inclination and excavation depths (including utility trench excavations) should in no case exceed those specified in local, state or federal safety regulations.

1.4 REGULATORY REQUIREMENTS

- A. Do not interrupt existing utilities serving facilities occupied and used by Owner or others except when permitted in writing by Owner or Owner's Representative and then only after acceptable temporary utility services have been provided. Provide minimum of 48-hour notice prior to enacting an approved temporary interruption.

1.5 SUBMITTALS (RESERVED)

PART 2 – PRODUCTS (RESERVED)**PART 3 – EXECUTION**

3.1 EXAMINATION

- A. Site Information
 - 1. Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly

understood that Owner will not be responsible for interpretations or conclusions drawn there from by Contractor. Data are made available for convenience of Contractor.

2. Contractor shall be responsible for determining the actual ground water elevation and soil conditions at the specific site prior to commencing with the excavation. It may be expedient to drill auger holes, excavate test pits or make additional soil borings at or adjacent to the construction area immediately prior to construction to determine the prevailing soil conditions and water table elevation. It is the Contractor's responsibility to make auger holes, excavate test pits or make additional soil borings, as he deems appropriate to determine the ground water and soil conditions that will be encountered. Additional test borings and other exploratory operations made by the Contractor shall be at no cost to the Owner.

3.2 PREPARATION

- A. Establish extent of excavated areas.
 1. Identify and set required lines, levels and contours.
 2. Maintain benchmarks, monuments and other reference points.
 3. Before starting excavation, establish location and extent of underground utilities occurring in work area. Contact Joint Utility Locating Information for Excavators (J.U.L.I.E.) (800) 892- 0123 or all other utility companies on the project site which are not members of this system.

3.3 EXCAVATION

- A. General
 1. Excavation consists of removal and redistribution of material encountered when establishing required grade and subgrade elevations, including stripping of topsoil.
 2. The Contractor is solely responsible for designing and constructing stable excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. All excavations shall comply with applicable local, state and federal safety regulations including the current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successor regulations.
 3. All sheeting, shoring and bracing of trenches, pits and excavations shall be the sole responsibility of the Contractor.
 4. Construction site safety is the sole responsibility of the Contractor, including but not limited to, the means, methods, and sequencing of construction operations.
 5. Earth excavation consists of stripping of topsoil, removal and disposal of pavements and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, material of any classification indicated in data on sub-surface conditions, and other materials encountered that are not classified as unauthorized excavation.
- B. Unauthorized Excavation
 1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Owner or Owner's Representative. Unauthorized excavation, as well as remedial work directed by Owner or Owner's Representative, shall be at Contractor's expense.

Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, only when acceptable to the Owner or Owner's Representative. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of the same classification, unless otherwise directed by Owner or Owner's Representative.

C. Additional Excavation

1. When excavation has reached required sub-grade elevations, notify Owner or Owner's Representative who will make an inspection of conditions. If unsuitable bearing materials are encountered at required sub-grade elevations, carry excavations deeper and replace excavated material as directed by Owner or Owner's Representative. Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to change in work.

D. Dewatering

1. Prevent surface water and subsurface or ground water from flowing into excavation and from flooding project site and surrounding area.
2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

E. Material Storage

1. Stockpile satisfactory excavated materials in the location designated by the Owner or Owner's representative, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain. Contain excavated silt/soil runoff with silt fences in accordance with Local, State and Federal Requirements. Silt fences.

F. Excavation Near Utilities

1. Protect, support, shore, brace, etc. all utility services uncovered by excavation.
2. Accurately locate and record abandoned and active utility lines rerouted or extended, on Contract Documents.
3. Repair damaged utilities to the satisfaction of the Utility Owner.

G. Disposal of Excess and Waste Materials

1. Removal from Owner's Property
 - a. Remove waste materials, trash and debris and legally dispose of it off Owner's property.

2. Excess Material
 - a. Excess excavated material shall be removed from the site and properly disposed of.

H. Topsoil

1. Topsoil shall be stripped from site so that all organic materials, stumps, and roots are removed from the site.
2. Contractor shall stockpile sufficient clean topsoil onsite for reuse and shall dispose of all excess or unsuitable material in accordance with existing state and federal regulations.
3. Temporary topsoil stockpiles shall be temporarily stabilized as required.

3.4 FIELD QUALITY CONTROL

- A. The Contractor shall allow bearing surfaces at the bottom of excavations to be inspected by the Owner or Owner's Representative, and shall modify the bearing surfaces as requested by the Owner or Owner's Representative, prior to placement of any base materials.
- B. Proofrolling. Subgrades shall be proofrolled to detect areas of insufficient compaction. Proofrolling shall be accomplished by making minimum of 2 complete passes with fully-loaded tandem-axle dump truck with a maximum weight of 20 tons, or approved equal, in each of 2 perpendicular directions while under the supervision and direction of the independent testing laboratory. Areas of failure shall be excavated and recompacted as specified herein. Continual failure areas shall be stabilized at no additional cost to Owner. Subgrade exposed longer than 48 hours or on which precipitation has occurred shall be re- proofrolled.

3.5 PROTECTION

A. Stability of Excavation

1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible either because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

B. Cold Weather Protection

1. Protect excavation bottoms against freezing when atmospheric temperature is less than 35OF (10C).

C. Protection of Persons and Property

1. Fence and barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required by authorities having jurisdiction.
2. Protect structures, landscaping, utilities, sidewalks, pavements or other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

3. Comply with current OSHA Occupational Safety and Health Standards - Excavations, 29 CFR Part 1926, including any successor regulations.

END OF SECTION 312316

SECTION 312323 – FILL**PART 1- GENERAL**

1.1 WORK INCLUDES

- A. Preparation of subgrade for pavements, sidewalks and curb and gutters.
- B. Backfill for site utilities.
- C. Fill for over-excavation.
- D. Consolidation and compaction of all fill material.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 312316 – Excavation
 - 2. Section 321216 – Asphalt Paving
 - 3. Section 321313 – Concrete Paving

1.3 REFERENCE TO STANDARDS

- A. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
- B. ASTM D4253 - Maximum Index Density and Unit Weights of Soils Using a Vibratory Table.
- C. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, Latest Edition.
- D. Illinois Department of Transportation (IDOT) – Project Procedures Guide, Latest Edition.

1.4 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Sections 202, 205 and 301 of the Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, including all Supplemental Specifications and Recurring Special Provisions.

1.5 SUBMITTALS

- A. Submit copies of Standard Proctor Density Test results to Owner or Owner's Representative a minimum of seven business days prior to backfilling any excavations.

1.6 QUALITY ASSURANCE

A. Compaction Testing

1. Standard Proctor Density Testing and Compaction Testing of fill materials and inspection of subgrades and fill layers will be performed by the Contractor's testing service, using Proctor information furnished by the Contractor.
2. If, in opinion of Owner or Owner's Representative, based on testing service reports and inspection, subgrade or fills, which have been graded or placed on-site are below specified density, provide additional compaction and testing at no additional expense to the Owner.
3. When, during progress of work, tests indicate that compacted materials will not meet specifications, remove defective work, replace and retest at no additional cost to the Owner.
4. Ensure that all compacted fills are tested before proceeding with placement of surface materials.

1.7 FIELD TESTS

A. Compaction Tests

1. Contractor shall make arrangements with an independent laboratory for making compaction tests and shall pay for those tests. They shall also make arrangements with testing firm to have sufficient number of personnel from the testing laboratory and testing equipment in good working order during all placement and compaction operations. Name of testing firm chosen by Contractor shall be submitted to Owner or Owner's Representative for approval prior to beginning of backfilling. Owner or Owner's Representative reserves right to reject testing firm at anytime during construction and to require another testing firm to perform tests.

1.8 PROTECTION

- A. Protect and avoid all existing underground utilities during construction operations. Repair of any utilities damaged by construction shall be the responsibility of the respective Contractor.

PART 2 - PRODUCTS

2.1 DEFINITIONS

A. Suitable Soil

1. Suitable soil is a soil having less than 5% organic matter by weight as determined by the Loss on Ignition Test (determine weight loss caused by heating sample to 500°C for 6 hours after drying in accordance with ASTM D-2216, "Laboratory Determination of Moisture Content of Soil").

B. Unsuitable Soil

1. Unsuitable soil is a soil that contains 5% or more organic matter as determined by the Loss of Ignition Test previously specified, rubbish, vegetable matter of every kind, roots, and boulders larger than 5 inches in dimension which might interfere with the proper bonding to adjacent contact surfaces, or as otherwise determined unsuitable by the Owner or Owner's Representative.

C. Cohesive Soil

1. Cohesive soil is a soil containing more than 50 percent fine material passing the No. 200 standard sieve, and with more than 15 percent clay-size particles smaller than 0.002 mm (2 microns). The soil matrix passing the No. 40 standard sieve exhibits dry (crushing) strength in the dry state and cohesive shear strength in the moist state, as well as being plastic in the moist state.

2.2 ENGINEERED FILL MATERIALS

A. General

1. Fill shall meet the requirements of IDOT CA-6 (Class C quality or better) or shall be composed of suitable lean (silty or sandy) clay with liquid limit no greater than 50% and plasticity index no greater than 25%. The on-site clay materials obtained from excavations may be allowed as engineered fill if the material meets these requirements.
2. Engage a qualified independent testing laboratory to test materials from on-site and off-site sources to test materials for conformance to this specification. The name of the testing laboratory shall be submitted to the Owner or Owner's Representative for review prior to conducting any tests. Results of tests shall be submitted to the Owner or Owner's Representative for review prior to engineered fill material being placed.

2.3 TRENCH BACKFILL MATERIALS

A. General Fill and Cohesive Backfill

1. Provide acceptable soil materials for backfill, free of clay lumps, rock or gravel larger than two inches in dimension, debris, waste, frozen materials, vegetable and other deleterious matter.

B. Granular Backfill and Trench Backfill

1. Granular backfill shall consist of IDOT FA-1, FA-2, FA-5, FA-6, CA-6 or CA-7. Granular backfill shall be used under steps, stoops, walks, roads, parking lots and against structure walls. (Minimum for inch depth below walks, steps, etc.).

PART 2 - PRODUCTS

3.1 EXAMINATION

- A. Prior to placement of any fill or backfill and prior to placement of all subsequent fill lifts, contact Owner or Owner's Representative for inspection and testing of excavation subgrade and testing of each compacted layer of fill and backfill material. Provide proctor information necessary for the Owner or Owner's Representative to perform density testing on in-place backfill material.

3.2 PREPARATION

- A. Backfilling and compaction shall not occur until the following conditions are satisfied:
 - 1. Acceptance by Owner or Owner's Representative of construction below finish grade.
 - 2. Inspection, testing, approval and recording locations of underground utilities.
 - 3. Removal of concrete formwork.
 - 4. Removal of trash and debris, vegetation, snow or ice, water, unsatisfactory soil materials, obstructions and deleterious materials.
 - 5. Removal of shoring and bracing and backfilling of voids with satisfactory material.
 - 6. Ensure that ground surface within excavated area to be backfilled is not frozen.
 - 7. When existing ground surface has a density less than that specified under Article 3.03-C of this Section for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content and compact to required depth and percentage of maximum density.

3.3 BACKFILLING AND COMPACTING

- A. General
 - 1. Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
 - a. In existing turf areas, use satisfactory excavated or borrow exterior fill material.
- B. Placement and Compaction
 - 1. Place backfill, base and fill materials in layers not more than 8

inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand operated tampers. Heavy equipment including compaction equipment shall not operate within 2 feet of unbraced substructure walls. Compaction in these areas shall be obtained with hand operated compaction equipment or devices. Earth backfill and native soil backfill shall be compacted with sheepsfoot compaction equipment.

2. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen or contain frost or ice.
3. Place backfill and fill materials evenly adjacent to structure to required elevations. Take necessary precautions to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.

C. Percentage of Maximum Density Requirements

1. Unless otherwise noted on the plan sheets, compact each layer of 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 D698, Standard Proctor Compaction Test; and not less than the following percentages of relative density, determined in accordance with ASTM D 4253 and ASTM D 4254, for soils which will not exhibit a well-defined moisture-density relationship (cohesion less soils).

REQUIRED COMPACTIVE EFFORT				
MATERIAL TESTED	PROCTOR TYPE	MIN % DRY DENSITY	MOISTURE CONTENT	MIN FREQUENCY OF TESTING
Engineered Fill	Standard	97%	-2 to +3%	1 per 2,500 sf of fill placed
Landscape Fill (non-load bearing)	Standard	90%	-2 to +3%	1 per 5,000 sf of fill placed
Utility Trench	Standard	97%	-2 to +3%	1 per 100 lf of backfill placed

D. Moisture Control

1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water top surface or subgrade or layer of soil material,

to prevent free water appearing on surface during or subsequent to compaction operations. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

E. Grading

1. General

- a. Uniformly grade areas within limits of excavation under this Section, including adjacent transition areas. Compact with uniform levels or slopes between such points and existing grades.
- b. Remove stones over 1-1/2" in any dimension and sticks, roots, rubbish and other extraneous matter.
- c. Rough grade to 6" - 12" below finish, grades and elevations indicated in the drawings.
- d. Grading Outside Structure Lines
 1. Grade areas adjacent to building lines to drain away from structures and to prevent ponding.
 2. Finish surfaces free from irregular surface changes, and as follows:
 - a. Slabs: Shape surface of areas under slabs to line, grade and cross-section, with finish surface not more than 1/2" above or below required subgrade elevation.

2. Grading Surface of Backfill Under Walks and Slabs.

- a. Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/4" when tested with a 10' straightedge.

3. Compaction

- a. After grading, compact subgrade surfaces to the depth and percentage of maximum or relative density for each area classification.

F. Maintenance

1. Protection of Graded Areas

- a. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

- b. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
 2. Reconditioning Compacted Areas
 - a. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape and compact to required density prior to further construction.
 3. Settling
 - a. Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of surface or finish to match adjacent work and eliminate evidence of restoration to greatest extent possible.

3.4 FIELD QUALITY CONTROL

- A. Quality Control Testing During Construction
 1. Allow the Owner or Owner's Representative to inspect subgrades and fill layers before further construction work is performed.
 2. If in opinion of Owner or Owner's Representative, based on field density testing and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense to the Owner.

END OF SECTION 312323

SECTION 321123 – AGGREGATE BASE COURSES**PART 1 - GENERAL**

1.1 WORK INCLUDES

- A. Furnish, place and compact an aggregate base course under the proposed Portland cement concrete and hot-mix asphalt pavements to the depths and at the locations shown on the plans.
- B. Compacted aggregate base for utility equipment pads.

1.2 RELATED WORK

- A. Specified elsewhere:
 - 1. Section 312316 – Excavation.
 - 2. Section 312323 – Fill.
 - 3. Section 313200 – Soil Stabilization.
 - 4. Section 321216 – Asphalt Paving.
 - 5. Section 321313 – Concrete Paving.

1.3 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Section 351 of the Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, latest edition, including all Supplemental Specifications and Recurring Special Provisions.

1.4 SUBMITTALS

- A. Submit gradation and certification of material that is to be used to Owner or Owner's Representative for review.
- B. Submit name of material supplier.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Type B: Material used for aggregate base course shall be in accordance with Article 1004.04 of IDOT's Standard Specifications. IDOT's gradation CA-6 will be required unless otherwise approved by the Owner or Owner's Representative.
- B. General: The minimum sidewalk aggregate base thicknesses below are typical only and should be verified at the time a geotechnical analysis of the specific project site soil is performed and followed by the Geotechnical Engineer's pavement design recommendations.

1. For 4 ft up to 6 ft wide sidewalks: Minimum aggregate base thickness – 4-inches.
 2. For 6 ft wide sidewalks: Minimum aggregate base thickness – 6-inches.
 3. For sidewalks wider than 6 ft: Minimum aggregate base thickness – 6 inches.
- C. IDOT Type 5: Material to be placed as a 6-inch compacted base for utility equipment pads. Intended for use with small equipment pads. Further design considerations by a structural engineer will be required for large scale utility equipment.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify existing subgrade has been compacted and prepared and is dry and that all gradients and elevations are correct.

3.2 PREPARATION

- A. Correct any irregularities in gradient and elevations by scarifying, reshaping and re- compacting.
- B. Do not place fill on soft, muddy or frozen surfaces.
- C. Prior to placement of aggregate base course, the subgrade shall be prepared in accordance with Section 301 of the IDOT Standard Specifications and shall be proofrolled to detect areas of insufficient compaction. Proofrolling shall be accomplished by making a minimum of 2 complete passes with a fully loaded tandem-axle dump trump with a maximum weight of 20 tons, or approved equal, in each of 2 perpendicular directions. The Contractor shall document all proofroll procedure and results. Areas of failure shall be stabilized in accordance with Section 313200 – Soil Stabilization.
- D. Maintain moisture content of the subgrade between -2% and +3% optimum at the time of paving.

3.3 AGGREGATE PLACEMENT

- A. Spread aggregate over the prepared subgrade to the lines and grades shown in the plans in accordance with IDOT's Standard Specifications.
- B. Compact base material to not less than 97% standard proctor.
- C. Water shall be added as required by the Owner or Owner's Representative to obtain satisfactory compaction.

3.4 TOLERANCES. Top surface of aggregate: Plus or minus 1/4 in.

3.5 SURPLUS MATERIALS

- A. Remove surplus materials from site.

END OF SECTION 321123

SECTION 321216 – ASHALT PAVING**PART 1 – GENERAL**

1.1 WORK INCLUDES

- A. Cleaning and priming aggregate base courses for bituminous concrete binder course.
- B. Bituminous concrete binder and surface course paving at the locations indicated on drawings.
- C. Quality Control / Quality Assurance sampling and testing.

1.2 RELATED WORK

- A. Specified elsewhere:
 - 1. Section 312316 – Excavation
 - 2. Section 312323 – Fill
 - 3. Section 312500 – Erosion & Sedimentation Control (With SWPPP)
 - 4. Section 313200 – Soil Stabilization

1.3 REGULATORY REQUIREMENTS

- A. Conform to the current and applicable portions of Section 406 of the Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, latest edition, including all Supplemental Specifications and Recurring Special Provisions.

1.5 QUALITY ASSURANCE

- A. Mix designs shall be for bituminous concrete mixes approved and used by IDOT within the last year.
- B. Mixing Plant: Conform to IDOT's prequalification requirements for producing IDOT specified mix designs.
- C. Obtain materials from same source throughout paving operations.

1.6 SUBMITTALS

- A. Submit IDOT approved mix designs of each class of mix and IDOT approved material sources for review at least four weeks prior to beginning of work.

1.7 JOB CONDITIONS

- A. Provide access to job for all contractors and subcontractors by using drives to fullest extent possible and, when specified, by constructing temporary roadways on portions of base course.

- B. Delay bituminous paving until after primary construction work is complete; unless concrete trucks, material delivery trucks, and other heavy construction vehicles can be detoured around roadway.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not place bituminous mixtures when ambient air or base temperature is less than 40 degrees F or surface is wet or frozen.

PART 2 – PRODUCTS

2.1 BITUMINOUS CONCRETE BINDER AND SURFACE COURSE

- A. Materials: Conform to the Illinois Department of Transportation's Standard Specification. Mixes shall conform to the following:
 - 1. Bituminous Concrete Binder Course:
 - a. PG 64-22
 - b. RAP % (Max) = 25
 - c. Design Air Voids – 4.0% @ Ndesign = 50
 - d. Mixture Composition (Gradation Mixture) – IL-19.0
 - 2. Bituminous Concrete Surface Course:
 - a. PG 64-22
 - b. RAP % (Max) = 15
 - c. Design Air Voids - 4.0% @ Ndesign = 50
 - d. Mixture Composition (Gradation Mixture) - IL-9.5 (Mix C)
- B. RAP Materials: Conform to the Illinois Department of Transportation's Special Provision, "Reclaimed Asphalt Pavement (RAP)" and as specified herein. Up to 25% RAP will be allowed in the binder course and up to 15% RAP in the surface course.
- C. Prime Coat: Medium curing cut-back asphalt or asphalt emulsion penetrating prime coat consisting of either MC-30, SS-1h, Asphalt Emulsion Prime (AEP), or equivalent.
- D. Tack Coat: Emulsified asphalt; AASHTO M140 or AASHTO M208, SS-1h, CSS-1, or CSS-1h, may be diluted with up to 1 part water to 1 part asphalt.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Inspect areas and conditions where bituminous concrete paving is to be installed.
 - 1. Proof roll subgrade with loaded tandem vehicle to verify that subgrade is dry and compacted and ready to support paving operations.
 - 2. Notify Owner or Owner's Representative of conditions detrimental to proper and timely completion of work.
 - 3. Request resolution of conditions.

- B. Protection:
 - 1. Provide protection for all adjacent work and areas.

3.2 PREPARATION – BITUMINOUS PRIME MATERIAL

- A. Apply bituminous prime coat to aggregate base course in accordance with IDOT Standard Specifications.
- B. Apply bituminous prime to contact surfaces of curbs, gutters and pavement edges.
- C. Use clean sand to blot excess primer.
- D. Apply bituminous prime to binder course prior to placement of the surface course as directed by the Owner or Owner's Representative.

3.3 FRAME ADJUSTMENTS

- A. Set frames for manholes and other units, within areas to be paved, to final grade as part of this work.
 - 1. Include existing frames or new frames furnished in other sections of these specifications.
- B. Surround frames set to grade with ring of compacted bituminous base prior to paving.
 - 1. Place bituminous mixture up to 1 inch below top of frame, slope to grade and compact with hand tamp.
- C. Adjust frames to proper grade for paving.
 - 1. Provide temporary closures over openings until completion of rolling operations.
 - 2. Remove closures at completion of work.
 - 3. Set cover frames to grade, flush with surface of adjacent pavement.

3.4 BITUMINOUS CONCRETE BINDER AND SURFACE COURSE

- A. Construct in accordance with IDOT Standard Specifications.
 - 1. Work includes complete construction of courses on prepared base course indicated on drawings, profiles and typical sections for proposed paved parking areas.

3.5 CONSTRUCTION TESTING

- A. Contractor shall complete all Quality Control / Quality Assurance testing in accordance with IDOT's Standard Specifications.
- B. Owner shall provide and pay for an independent testing company to complete the Quality Assurance tests outlined to be completed in IDOT's Standard Specification.

END OF SECTION 321216

SECTION 321313 – CONCRETE PAVING**PART 1 – GENERAL**

1.1 WORK INCLUDES

- A. Concrete driveway pavements.
- B. Concrete sidewalks.
- C. Concrete curb and gutters.

1.2 RELATED WORK

- A. Specified elsewhere:
 - 1. Section 024100 – Demolition
 - 2. Section 312316 – Excavation
 - 3. Section 312323 – Fill

1.3 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Section 420, 424 and 606 of the Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, latest edition, including all Supplemental Specifications and Recurring Special Provisions.
- B. Illinois Department of Transportation (IDOT) – Project Procedures Guide, latest edition.
- C. Applicable IDOT Highway Standards – Attached at end of this Section.

1.4 QUALITY ASSURANCE

- A. Conform to the Illinois Department of Transportation's Recurring Special Provision Check Sheet #31, "Quality Control / Quality Assurance of Concrete Mixtures" (Revised January 1, 2009).

1.5 REFERENCES

- A. American Concrete Institute (ACI) ACI 330R-08 – Guide for the Design and Construction of Concrete Parking Lots.

1.6 JOB CONDITIONS

- A. Traffic Control:
 - 1. Restrict traffic from access any concrete slab for a minimum 7 days unless tests are made to determine that the concrete has gained adequate strength.

1.7 SUBMITTALS

- A. Submit mix designs, materials mix ratio and laboratory test data to the Owner or Owner's Representative prior to beginning paving activities.
- B. Submit jointing plan for each concrete pavement area to the Owner or Owner's Representative for review and approval prior to beginning paving activities.

PART 2 – PRODUCTS

2.1 FORM MATERIALS, REINFORCEMENT AND CONCRETE

- A. Materials: Conform to Section 1103 of the IDOT Standard Specifications for the given type of work to be performed, unless otherwise approved by the Owner or Owner's Representative.

2.2 EXPANSION JOINTS

- A. Materials: In conformance with IDOT Standard Specifications, except do not use bituminous poured joint materials in sidewalks; seal joints.

2.3 CONCRETE MIXES (PAVING)

- A. Concrete: Conform to Section 1020 of the IDOT Standard Specifications for the given type of work to be performed, unless otherwise approved by the Owner or Owner's Representative.
- B. Do not use chloride or other chemicals to prevent freezing.
- C. Provide 5% - 7% Air Entrainment.

2.4 MINIMUM CONCRETE SIDEWALK THICKNESSES

- A. General: The minimum sidewalk thicknesses below are typical only and should be verified at the time a geotechnical analysis of the specific project site soil is performed and followed by the Geotechnical Engineer's pavement design recommendations.
- B. For 4 ft wide up to 6 ft. sidewalks: Minimum 5-inches thick.
- C. For 6 ft wide sidewalks: Minimum 6-inches thick.
- D. For sidewalks wider than 6 ft.: Minimum 7-inches thick.

2.5 FIBER REINFORCEMENT (FOR ALL SIDEWALK WIDTHS)

- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C1116/C1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm).
- B. Synthetic fiber: Uniformly disperse in concrete mixture at manufacturer's

recommended rate but not less than 1.0 lb/cu. yd.

2.6 STEEL REINFORCEMENT (FOR SIDEWALKS 6 FT WIDE AND WIDER THAN 6 FT)

- A. For 6 ft. Wide Sidewalks: Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from galvanized steel wire into flat sheets.
- B. For Sidewalks Wider than 6 ft.: Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, Grade 60 (Grade 420) deformed bars.
- C. For Sidewalks 6 ft wide and wider than 6 ft.: Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.7 GEOSYNTHETIC FABRIC (FOR ALL SIDEWALKS)

- A. General: Geosynthetic fabric to be used as a liner between the soil subgrade and sidewalk aggregate base.
- B. Geosynthetic Fabric Material:
 - 1. TenCate Mirafi RS280i
 - 2. Equal as approved by UIS Facilities.
- C. Mechanical Properties:
 - 1. Tensile Strength @ 2% Strain (MD), ASTM D4595, 840 lbs/ft
 - 2. Tensile Strength @ 2% Strain (CD), ASTM D4595, 960 lbs/ft
 - 3. Tensile Strength @ 5% Strain (MD), ASTM D4595, 1,980 lbs/ft
 - 4. Tensile Strength @5% Strain (CD), ASTM D4595, 2,100 lbs/ft
 - 5. Flow Rate, ASTM D4491, 85 gal/min/ft²
 - 6. Permittivity, ASTM D4491, 1.2 sec⁻¹
 - 7. Pore Size 0₉₅, ASTM D6767, 273 microns
 - 8. Pore Size 0₅₀, ASTM D6767, 175 microns
- D. Index Properties:
 - 1. Apparent Opening Size (AOS), ASTM D4751, 40 U.S. Sieve
 - 2. Interaction Coefficient², ASTM D6706, 0.89
 - 3. Factory Sewn Seam, ASTM D4884, 2,400 lbs/ft
 - 4. UV Resistance (at 500 hours), ASTM D4355, 90% strength retained

PART 3 – EXECUTION

3.2 INSPECTION

- A. Inspect areas and conditions where concrete paving is to be installed.
 - 1. Notify Owner or Owner's Representative, in writing, of conditions detrimental to proper and timely completion of work.

3.3 FACILITIES

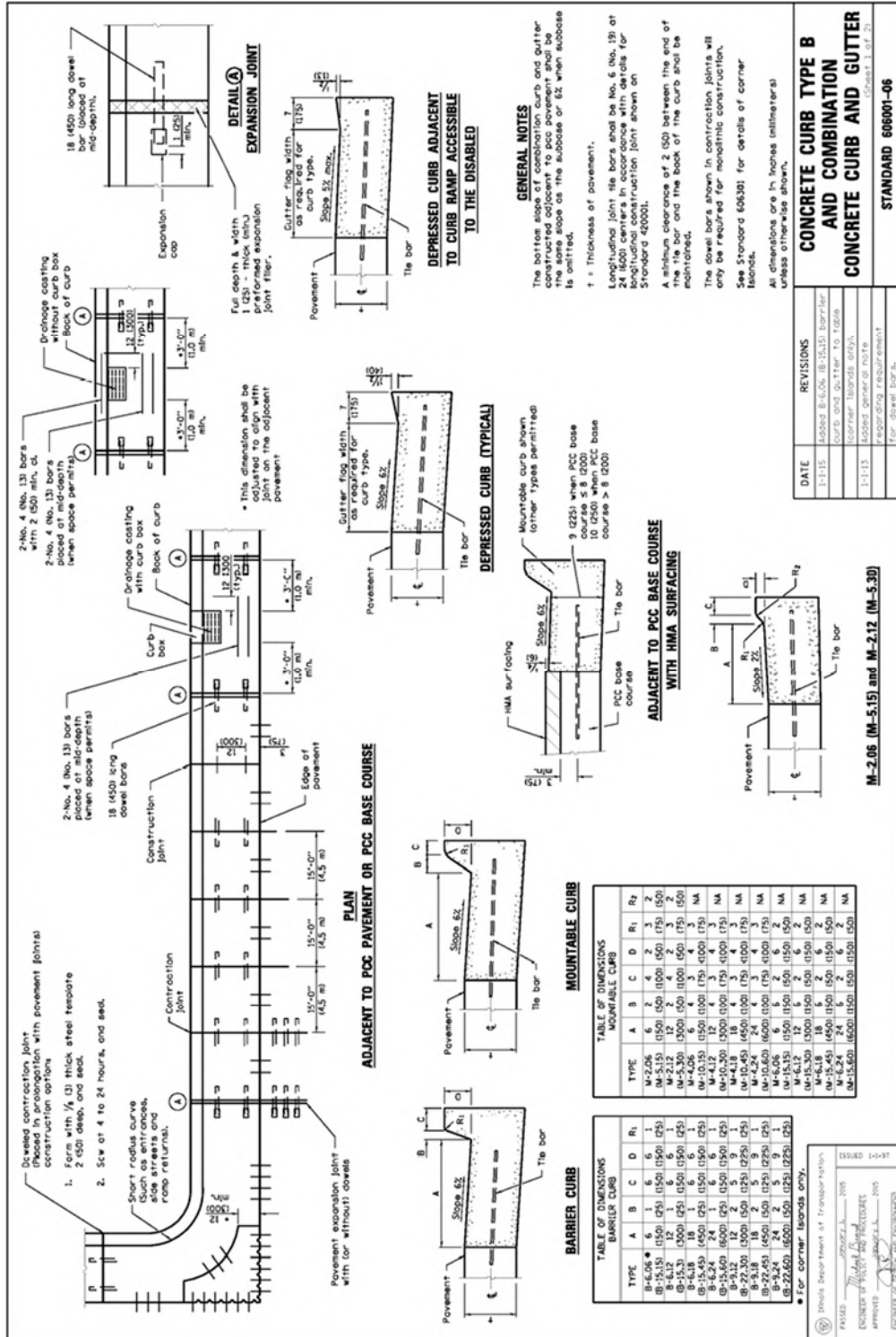
- A. Locate manholes, valve boxes and similar items; adjust to proposed concrete surface elevation.

3.4 CONSTRUCTION METHODS

- A. Concrete shall be placed in accordance IDOT's Standard Specifications.
- B. Joints shall be tooled and located at a spacing equal to the width of the sidewalk or as noted on the plans and details.

3.5 CONSTRUCTION TESTING

- A. Contractor shall provide and pay for an independent testing company to complete the Quality Assurance tests outlined to be completed by the Department in IDOT's Standard Specification.



SECTION 32 1315 – SPECIAL 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.

1.1.1 SUMMARY

- A. Section Includes
 - 1. Site preparation
 - 2. Aggregate base
 - 3. Concrete borders
 - 4. Paver base
 - 5. Footings for site furnishings
- B. Related Requirements
 - 1. All related exterior improvement work

1.3 DEFINITIONS

- A. The Illinois Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition, and all subsequent amendments referred herein as IDOT Standard Specifications
- B. The American Society for Testing and Materials (ASTM), current edition including all amendments

1.4 ACTION SUBMITTALS

- A. Product data
 - 1. List of equipment anticipated
 - 2. Mix design (to meet the requirements of ACI 318-89, Chapter 5)
- C. Mockups to be provided to assure quality, color, finishes, etc. If mockup is not satisfactory, more shall be done until satisfactory.

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years' experience in similar work. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor is responsible to protect and avoid all existing above ground and underground utilities during construction operations. Repair of any utilities damaged by installation shall be the responsibility of the Contractor.

- C. Contractor is responsible to protect all existing conditions including structures, pavement and plant material from damage during construction. Any damages occurring shall be the responsibility of the Contractor to replace, repair or compensate Owner for damages.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handle concrete so as not to cause separation or premature curing. Mix to thoroughly and uniformly incorporate all concrete components including color agents is required.

PART 2 – PRODUCTS

2.1 PRODUCTS AND MATERIALS

A. Base Aggregate

- 1. CA-6 class B crushed stone meeting the requirements of Section 1004 Coarse Aggregate, IDOT Standard Specifications.

B. Concrete Materials

- 1. Portland Cement conforming to ASTM C-150, Type 1 or 3.
- 2. Concrete aggregates conforming to ASTM C-33. The maximum size aggregate to be 1/5 of the narrowest dimension between sides of forms, 3/4 of the minimum clear distance between reinforcing bars, or 1/3 of the depth of slabs.
- 3. Water used in mixing concrete to be free from sewage, oils, acids, alkalis, salts, organics, or other deleterious materials. Water approved by Public Health Agencies for drinking may be accepted without being tested.
- 4. Steel reinforcement conforming to plans and Section 508. Reinforcement Bars and Section 1006. Metals, IDOT Standard Specifications.

C. Concrete Sealer

- 1. In accordance with Section 1026, IDOT Standard Specifications.

PART 3 – EXECUTION

3.1 CONCRETE QUALITY

- A. Unless otherwise specified, concrete to have a 28 day compressive strength of 4000 psi. Submit the mix design intended for use which has been proved by field test data or trial mixes.
- B. All exterior concrete to contain an air-entrained admixture conforming to ASTM C-260 to achieve an air content of 4-1/2 % to 7-1/2%. The mixture to be such that the concrete will work readily into the corners and angles of the forms and around the reinforcements with the method of placing employed on the work without permitting segregation of aggregate or excess free water.
- C. Place a uniform thickness of base material to yield a finished thickness as shown on plans when compacted. The material shall be rolled to achieve a compaction density of 95% or as approved by Owner’s Representative.

3.2 CONSTRUCTION METHODS

A. Concrete Installation

1. Before placing concrete, all equipment for mixing and transporting concrete to be clean, all debris and ice to be removed from formed areas, the forms to be thoroughly wetted or oiled, and reinforcing to be cleaned. If the forms are to be oiled, oiling shall be done prior to placement of reinforcing. Do not place concrete in water.
2. Job mixed concrete to be mixed in an approved mixer for a period of not less than one minute after all materials are in the mixer. Ready-mix concrete to be mixed and delivered in accordance with ASTM C-94.
3. Concrete to be conveyed to the place of final deposit by methods which will prevent segregation. Concrete that is contaminated, partially hardened, or re-tempered will not be used. Once started, concrete placement to be carried on as a continuous operation until a complete section is done. Concrete to be thoroughly consolidated by mechanical vibrators. Contact with the forms to be insured by spading.

3.3 CURING

- A. Maintain concrete in a moist condition for at least 5 days after placement, except that for early high-strength concrete, provide moist curing for at least the first two days.
- B. Place wetted burlap and polyethylene sheeting or curing membrane over concrete has been finished, immediately after the water sheen is no longer visible on the concrete surface.

3.4 COLD AND HOT WEATHER REQUIREMENTS

- A. Cold weather concreting to be performed in accordance with "Recommended Practice for Cold Weather Concreting" and/or the latest edition of the PCA publication entitled "Cold Weather Concreting" (PCA ST-94).
- B. Hot weather concreting and curing to be performed in accordance with the latest edition of ACI 305, "Recommended Practice for Hot Weather Concreting".

3.5 FORMS

- A. The design, engineering, and construction of formwork is the responsibility of the Contractor. Forms to be wood or metal, designed, fabricated, braced and maintained such that the finished concrete conforms to the true lines and dimensions specified in the plans. Forms to be tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other construction loadings, including vibration.
- B. The maximum deflection of facing forms reflected in concrete surfaces exposed to view to be no greater than 1/240 of the span between structural form members.
- C. Forms to be removed in a manner to ensure safety of the structure. Do not remove forms until concrete has acquired sufficient strength to safely support its weight and the load thereon.

3.6 REPAIR OF DEFECTIVE AREAS

- A. Repair work on defective areas of all sizes to have prior approval by the Owner's Representative. Methods and procedures shall be in accordance with ACI 301, Chapter 9 except as modified herein.
- B. As early as possible after the removal of the forms, patch any poor joints, voids, air pockets and minor honeycombs. Large areas of honeycomb and other weak areas to be chipped out with a light pneumatic chip-hammer.

- C. Repair of all defects to be accomplished by first wetting the area followed by the application of a bonding grout consisting of one-part cement and one-part sand (passing the No. 30 sieve) mixed to the consistency of thick cream. The patching material to consist of one part of gray and white portland cement so proportioned with 2 1/2 parts of sand (passing the No. 30 sieve) and enough water to produce a workable mixture which, when in place and cured, will match the color of the unmarred surfaces.

3.7 CONSTRUCTION JOINTS

- A. Space construction joints along the length of the pavement and borders and as shown on plans.
- B. Joints to be tooled 1-1/2 inch-deep, straight and perpendicular to the pavement edge unless otherwise indicated.
- C. Cut joints will not be allowed.
- D. Joints not indicated on the plans to be located to fit the pattern and design of the surface as determined by the Owner's Representative.

3.8 EXPANSION JOINTS

- A. Space expansion joints approximately every 30 feet along the length of the pavement and borders as shown on plans. Locate expansion joints along edges of all adjacent structures including building and site walls.
- B. Joints to be full depth and filled with 1/2-inch-thick asphaltic coated expansion material to within 1/4 inch of the finished sidewalk surface.
- C. Fill joints with joint sealer to meet adjoining concrete elevations.

3.9 EDGES

- A. Tool all exposed edges with a 1/2 inch-diameter round over.

3.10 SURFACE TEXTURE

- A. Concrete Border and edge surfaces: Medium-broom surface with texture running perpendicular to the length of pedestrian or vehicular travel.
- B. Footings: Exposed surfaces to be hand rubbed.

3.11 CONCRETE SEALING

- A. Seal all exposed concrete after 30 days of curing.
 - 1. Clean surface thoroughly.
 - 2. Spray or roll on concrete surfaces. Allow to dry a minimum of 8 hours.
 - 3. Apply second coat.

END OF SECTION 32 1315

SECTION 32 1415 – UNIT PAVING (Precast Concrete or Brick)

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. Preparation of sub-grade
 - 2. Concrete base course
 - 3. Setting sand
 - 4. Unit pavers
- B. Related Requirements
 - 1. Section 321315 SPECIAL CONCRETE
 - 2. All related exterior improvement work

1.3 DEFINITIONS

- A. Illinois Department of Transportation Standard Specifications for Roads and Bridge Construction latest edition as amended, referred herein as IDOT Standard Specifications.

1.4 ACTION SUBMITTALS

- A. Product Information and Samples
 - 1. Cut sheets for unit pavers.
 - 2. Minimum 4 pavers representing full range of paver coloration.
- B. Equipment
 - 1. List of equipment anticipated for use.

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years' experience construction of similar structures. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor is responsible to protect and avoid all existing above ground and underground utilities during construction operations. Repair of any utilities damaged by construction shall be the responsibility of the Contractor.
- C. Contractor is responsible to protect all existing conditions including structures, pavement and plant material from damage during construction. Any damages occurring shall be the responsibility of the Contractor to replace, repair or compensate Owner for damages.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Materials to be handled as not to contaminate sand or chip or break pavers.

PART 2 – PRODUCTS

2.1 PRODUCTS AND MATERIALS

- A. Unit Pavers – Precast Concrete (not resistant to ice and snow melt)

1. Square pavers with beveled edges and spacer lugs. Top surface of pavers to have enhanced aggregate face mix.
2. Paver dimensions (dependent on manufacturer selected): approx. 12" x 12" x 3"
3. Two standard colors: Tan and Charcoal
4. Provided in quantities to complete the paved area in the pattern as shown on project plans.
5. Products and Manufacturers

- a. Holland Stone Paver (4" x 8" x 3.125"), texturegard, smooth finish as manufactured by Belgard Commercial – Northfield an Oldcastle Company, One Hunt Ct, Mundelein, IL 60060, 847/949-3600. www.belgardcommercial.com

- Standard Color #1 to be selected by Owner's Representative prior to product submittals.

- b. Holland Premier Paver (4" x 8" x 2.375") as manufactured by Unilock, 301 E. Sullivan Road, Auroa, IL 60540, 716/822-6074. www.unilock.com.

- Standard Color #1 to be selected by Owner's Representative prior to product submittals.

- c. Prest Pavers (4" x 8" x 2.375") with "Tudor #13" surface finish as manufactured by Hanover Architectural Products, 5000 Hanover Road, Hanover, PA 17331 800/426-4242. www.hanoverpavers.com

- Standard Color #1 to be selected by Owner's Representative prior to product submittals.

- d. Equal as approved by UIS Facilities.

- B. Brick Pavers (resistant to salt and ice melt)

1. Specify here
2. Equal as approved by UIS Facilities.

- C. Setting sand: fine crushed stone aggregate gradation FA8 in compliance with Section 1003, Fine Aggregate, IDOT Standard Specifications.

- D. Concrete Base: as specified in Section 32 1315 – SPECIAL CONCRETE (specifications for this project).

- E. Filter Fabric: 6 oz. weight non-woven fabric meeting standards of Section 282 – Filter Fabric, IDOT Standard Specifications.

PART 3 - EXECUTION

3.1 CONCRETE BASE AND EDGING

- A. Concrete Base and Edging to be constructed in accordance with Section 321315 SPECIAL CONCRETE
 - 1. Prepare sub-grade.
 - 2. Concrete base and edging as shown on plans.
 - a. Tool all exposed edges.
 - b. Medium broom all exposed surfaces.
 - c. Coarse broom base surface.
 - d. Provide drainage holes.

3.2 FILTER FABRIC

- A. Placement
 - 1. Place filter fabric on top of concrete base course prior to sand placement.

3.3 SETTING SAND

- A. Placement
 - 1. Place Setting Sand on concrete base.
 - 2. Screed sand to achieve
 - a. A fluffed-up thickness of ½" to 1".
 - b. A smooth and uniformly sloped surface as shown on the plans.

3.4 UNIT PAVERS

- A. Lay Pavers
 - 1. Use only pavers that are in good condition, free from cracking, chipping and other defacing conditions.
 - 2. Lay pavers on an area of freshly screened sand. It is recommended that a distinct area be installed and vibrated in place the same day.
 - 3. Set pavers in running bond pattern, as indicated on project plans.
 - 4. Cut pavers as necessary to fill areas. Cuts shall be at precise angles with no chipping or broken edges or gaps greater than 3/8".
- B. Set Pavers
 - 1. Sweep sand between joints.
 - 2. Mechanically vibrate surface with care to achieve a uniform surface.
 - 3. Repeat process until joints are completely filled and the surface is smooth and uniform, meeting lines and grades shown on plan.

- C. Check Surface

1. Carefully check surface and replace any cracked or broken pavers.
2. Repeat sand joint filling process sixty (60) days after initial installation to fill any voids due to settlement.

END OF SECTION 32 1415

SECTION 32 1445 – PERMEABLE UNIT PAVING (Precast Concrete or Brick)

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. Preparation of sub-grade
2. Geo-textile fabric
3. Perforated PVC pipe
4. Aggregate sub-base course
5. Aggregate base course
6. Aggregate bedding course
7. Permeable pavers
8. Concrete edge restraints
9. Utility boxes

B. Related Requirements

1. All related exterior improvement work

1.3 DEFINITIONS

- A. The Illinois Department of Transportation Standard Specifications for Road and Bridge Construction latest edition and all subsequent amendments referred herein as IDOT Standard Specifications.
- B. American Society for Testing and Materials (ASTM) C902-79 Pedestrian List Traffic Paving Brick.

1.4 ACTION SUBMITTALS

A. Product Data

1. Paver product information including color chart with selected color.
2. Samples: Minimum of 3 pavers representing full range of coloration.
3. List of equipment anticipated for use.

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years' experience construction of similar pavement types. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor is responsible to protect and avoid all existing above ground and underground utilities during construction operations. Repair of any utilities damaged by installation shall be the

responsibility of the Contractor.

- C. Contractor is responsible to protect all existing conditions including structures, pavement, and plant material from damage during project installation and maintenance. Any damages occurring are the responsibility of the Contractor to replace, repair, or compensate Owner for damages.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle to prevent damage to the products and materials.

PART 2 – PRODUCTS

2.1 PRODUCTS AND MATERIALS

- A. Permeable Pavers, Rectangular Shape – Cast Concrete (not tolerant of salt and ice melt)

1. Rectangular pavers with beveled edges and spacer lugs. Top surface of pavers to have enhanced aggregate face mix.
2. Paver dimensions (dependent on manufacturer selected): approx. 4.5" x 9" x 3.15"
3. Provided in quantities to complete the paved area, herringbone pattern for mechanical installation.
4. Products and Manufacturers
 - a. Aqualine Series (4.5" x 9" x 3.15"), Texturgard, smooth finish as manufactured by Belgard Commercial – Northfield an Oldcastle Company, One Hunt Ct, Mundelein, IL 60060, 847/949-3600. www.belgardcommercial.com
 - Standard Color #1 to be selected by Owner's Representative prior to product submittals.
 - b. Eco-Priora (4.72" x 9.45" x 3.15") enduracolor, smooth finish as manufactured by Unilock, 301 E. Sullivan Road, Auroa, IL 60540, 716/822-6074. www.unilock.com
 - Standard Color #1 to be selected by Owner's Representative prior to product submittals.
 - c. Permeable (4.5" x 9" x 3") with "Tudor #13" surface finish as manufactured by Hanover Architectural Products, 5000 Hanover Road, Hanover, PA 17331 800/426-4242. www.hanoverpavers.com
 - Standard Color #1 to be selected by Owner's Representative prior to product submittals.
 - d. Equal as approved by UIS Facilities.

- B. Permeable Pavers, Square Shape – Cast Concrete (not tolerant of salt and ice melt)

1. Square pavers with beveled edges and spacer lugs. Top surface of pavers to have enhanced aggregate face mix.
2. Paver dimensions (dependent on manufacturer selected): approx. 12" x 12" x 3.15"
3. Provided in quantities to complete the paved area in the pattern as shown on project plans.

4. Products and Manufacturers
 - a. Aqualine Series (12" x 12" x 3.15"), texture hard, smooth finish as manufactured by Belgard Commercial – Northfield an Oldcastle Company, One Hunt Ct, Mundelein, IL 60060, 847/949-3600. www.belgardcommercial.com
 - Standard Color #2 to be selected by Owner's Representative prior to product submittals.
 - b. Eco-Priora (9.45" x 9.45" x 3.15") enduracolor, smooth finish as manufactured by Unilock, 301 E. Sullivan Road, Auroa, IL 60540, 716/822-6074. www.unilock.com
 - Standard Color #2 to be selected by Owner's Representative prior to product submittals.
 - c. Permeable (12" x 18" x 3") with "Tudor #13" surface finish as manufactured by Hanover Architectural Products, 5000 Hanover Road, Hanover, PA 17331 800/426-4242. www.hanoverpavers.com
 - Standard Color #2 to be selected by Owner's Representative prior to product submittals.
 - d. Equal as approved by UIS Facilities.
- C. Permeable Pavers – Brick (salt and ice-melt resistant)
 1. List here.
 2. Equal as approved by UIS Facilities.
- D. Geo-textile Fabric: 6 oz. woven geo-textile fabric, in widths to minimize the need for overlapping meeting requirements of Section 282 – Filter Fabric of the IDOT Standard Specifications.
- E. PVC Pipe: 4" PVC pipe Schedule 160, perforated with fabric sock, meeting the requirements of Section 1040-Drain Pipe, Tile, Drainage Mat, and Wall Drain, IDOT Standard Specifications.
- F. PVC Adhesive: Standard PVC adhesive.
- G. Component Drain Tile Accessories (concrete headwall, rodent shield, fittings etc.), meeting the requirements of Section 1040-Drain Pipe, Tile, Drainage Mat, and Wall Drain, IDOT Standard Specifications and IDOT Standard Detail 601101-01.
- H. Sub-base Course: 2½" to 1½" aggregate size washed and cleaned of fines, CA-1 aggregate in compliance with Section 1004, Coarse Aggregate, IDOT Standard Specifications.
- I. Base Course: ¾" to 1" aggregate size, washed and cleaned of fines, CA-7 aggregate in compliance with Section 1004, Coarse Aggregate, IDOT Standard Specifications.
- J. Bedding Course: ¼" aggregate size washed and cleaned of fines, FA-8 aggregate in compliance with Section 1003, Fine Aggregates, IDOT Standard Specifications.
- K. Helix Anchors: One-piece steel earth anchor with eye ring and 6" dia. welded helix. 11/16" dia. x 45" shaft with an approximate holding capacity of 4,000 lbs.
- L. Utility Box: Polymer concrete utility box, 12-3/8" square base x 12-3/4" depth with polymer concrete cover. Two (2) stainless steel hex bolts to secure cover to box.

PART 3 – EXECUTION

3.1 PERMEABLE PAVERS

A. Sub-grade Preparation

1. Grade sub-grade to slope indicated on plan for drainage.
2. Remove and replace any soft areas according to Section 312219 – Finish Grading.

B. Concrete Edge Restraint

1. Form and pour concrete edge restraint in accordance with Section 321315 – Special Concrete.
2. Edge restraint to have expansion joints and construction joints as shown on plans.
3. Surface to be flush with finish grade of pavers.
4. Edges to be tooled with ½” round-over.
5. Surface to be medium broom.

C. Geo-textile Fabric

1. Lay fabric on prepared sub-grade.
2. Hold in position during placement of base course.

D. Install PVC pipe in accordance with Section 601.04, Pipe Underdrain Installation, IDOT Standard Specifications.

1. Installation in permeable paver areas.
 - a. Place continuous lines of perforated PVC pipe on subgrade in locations shown on plans.
 - b. Slope pipe to outlet at 1% minimum.
 - c. Connect pipe sections with fittings secured with adhesive.
 - d. Backfill with aggregate for permeable paver installation.
2. Installation in lawn areas
 - a. Cleanly excavate trenches to near tile elevations.
 - b. Place geotextile fabric along bottom of trench and up sides.
 - c. Place CA7 on trench bottom as needed to create smooth continuous grade.
 - d. Place continuous lines of perforated PVC pipe in trenches at minimum 1% slope.
 - e. Connect pipe sections with fittings secured with adhesive.
 - f. Backfilled perforated pipe with CA7 taking care not to dislocate tile.
 - g. Fold geotextile fabric over CA7 to enclose aggregate.
 - h. Backfill with approved topsoil to finish grade.
 - i. Install concrete headwall for pipe drain and rodent shield according to IDOT standard detail 601101-01.

E. Sub-base Course

1. Place CA-1 aggregate in lifts not to exceed 4 inches, compacting each lift.
2. Compact to density shown on plan.
3. Provide smooth surface grade.

F. Base Course

1. Place CA-7 aggregate in lifts not to exceed 4 inches, compacting each lift.
2. Compact to density shown on plan.
3. Provide smooth surface grade.

G. Bedding Aggregate

1. Place FA-8 bedding aggregate to depth shown on plans.
2. Screed to uniform thickness.
3. Provide smooth surface.

H. Pavers

1. Set pavers with tight joints in precise lines in pattern as shown on plans.
2. Cut pavers as necessary to fill paved areas. Cut at precise angles with no chipping or broken edges.
3. Sweep aggregate between joints into openings. Mechanically vibrate surface. Repeat process until joints are completely filled.
4. It is recommended that an area of pavers be installed and vibrated in place the same day.
5. Provide smooth surface slope to drain according to plan. Elevation to vary no more than 3/8 inch over any 3-foot section of paver.
6. Check surface carefully for uneven units and edges.
7. Remove and replace any damaged paver units.
8. Repeat aggregate joint filling process sixty (60) days after initial installation to fill any voids due to settlement.

I. Utility Boxes

1. Install utility access boxes in paved area at locations approved by Owner's Representative.
2. Top of box to be flush with pavers.
3. Secure cover to box with 2 stainless steel hex bolts as supplied by the manufacturer.

J. Maintenance

1. Inspect permeable paver joints six (6) months after initial installation. Joint aggregate has likely settled since the initial installation.
2. Clean any clogged areas.
3. Sweep aggregate into joint openings until joints are completely filled.

END OF SECTION 32 1445

SECTION 32 1500 – AGGREGATE SURFACING (Gravel Borders and Cobble Areas)

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. Ground Preparation
 - 2. Filter Fabric
 - 3. Gravel
 - 4. Stone Cobbles
- B. Related Requirements
 - 1. All exterior improvement work

1.3 DEFINITIONS

- A. The Illinois Department of Transportation Standard Specifications for Road and Bridge Construction latest edition and all subsequent amendments, referred herein as IDOT Standard Specifications.

1.4 ACTION SUBMITTALS

- A. Product Information and Samples
 - 1. Five (5) pound sample of gravel
 - 2. Five (5) cobble samples
 - 3. Cut sheet for filter fabric

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years experience in similar work. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor is responsible to protect and avoid all existing underground and above ground utilities during construction operations. Repair of any utilities damaged by installation is the responsibility of the Contractor.
- C. Contractor is responsible to protect all existing conditions including structures, pavements, and plant material from damage during project installation and maintenance. Any damages occurring are the responsibility of the Contractor to replace, repair or compensate Owner for damages.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle to prevent damage to the products and materials.

PART 2 – PRODUCTS

2.1 PRODUCTS AND MATERIALS

- A. Gravel: Smooth river gravel 1" to 2" diameter, light to medium tan color.
- B. Cobbles: Smooth river cobbles 2" to 6" diameter, light to medium tan color.
- C. Filter fabric: 6 oz. weight non-woven fabric meeting standards of Section 282. Filter Fabric, IDOT Standard Specifications.
- D. Staples for filter fabric: 11 gauge, "U" shaped with approximately 2 inches at the top and 6 inch legs.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Protection
 - 1. Mark the location of all utilities at the site.
 - 2. Stake the location of gravel borders as shown on plans.
 - 3. Provide safeguards to protect building, sidewalks, and other improvements from possible damage during construction.

3.2 INSTALLATION

- A. Ground Preparation
 - 1. Core-out areas for gravel mulch as shown on plans.
 - 2. Excavate to precise lines and right-angle edges.
 - 3. Bottom and sides of excavation to be undisturbed earth or compacted to 90% and to drain away from building.
- B. Geotextile Placement
 - 1. Place fabric across the bottom and extend up the vertical edges as shown on plans.
 - 2. Layout fabric with a minimum of joining. Where joining is necessary, overlap a minimum of 6 inches.
 - 3. Place fabric along the bottom of the border and extending up the vertical edges to within 2 inches of finish grade. Fold fabric back into the excavation.
 - 4. Pin edges and joining seams at 2 feet intervals.
- C. Gravel Borders
 - 1. Place gravel in the prepared beds to thickness shown on plans.
 - 2. Rake smooth.

D. Gravel and Cobbles

1. Contact Landscape Architect prior to beginning placement.
2. Place gravel and cobbles in the prepared beds as shown on plans.

END OF SECTION 32 1500

SECTION 321600 – CURB RAMPS**PART 1 – GENERAL**

1.1 WORK INCLUDES

- A. This work shall consist of constructing sidewalk curb ramps in accordance with Section 424 of the Standard Specifications and as detailed in the plans.
- B. This work shall also consist of furnishing all material, equipment, and labor necessary for the placement of cast iron detectable warning tiles at sidewalk curb ramps as detailed in the plans. All proposed sidewalks and sidewalk curb ramps shall comply with the latest version of the Illinois Accessibility Code.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 321313 - Concrete Paving

1.3 REGULATORY REQUIREMENTS.

- A. Conform to the applicable portions of Section 424 of the Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, including all Supplemental Specifications and Recurring Special Provisions.
- B. Conform to IDOT's Highway Standards included in the project details of these contract documents.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. All detectable warning surfaces shall conform to ANSI A117.1 – 1998 Accessibility Guidelines for Building Specifications. Submit manufacturer's certification of compliance with all applicable standards and drawings and/or catalog cut sheets to the Engineer for approval.
- B. Cast-in-Place Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
- C. Cast Iron: Gray iron, ASTM A 48/A 48M, CL 35.
- D. Shape and Sizes: Rectangular panel, 24 by 24 inches.
- E. Dome Spacing and Configuration: Truncated domes on detectable warning tiles shall have a base diameter of 0.9 inch (23 mm) minimum and 1.4 inches (36 mm) maximum; a top diameter of 50% of the base minimum and 65% of the base maximum; a height of 0.2 inch (5 mm) and a center-to-center spacing of 1.6 inches (41 mm) to 2.4 inches (61 mm).

- F. Mounting: Permanently embedded detectable warning tile wet-set into freshly poured concrete.
- G. Manufacturer:
 - 1. Neenah Foundry
 - 2. Equal as approved by UIS Facilities.

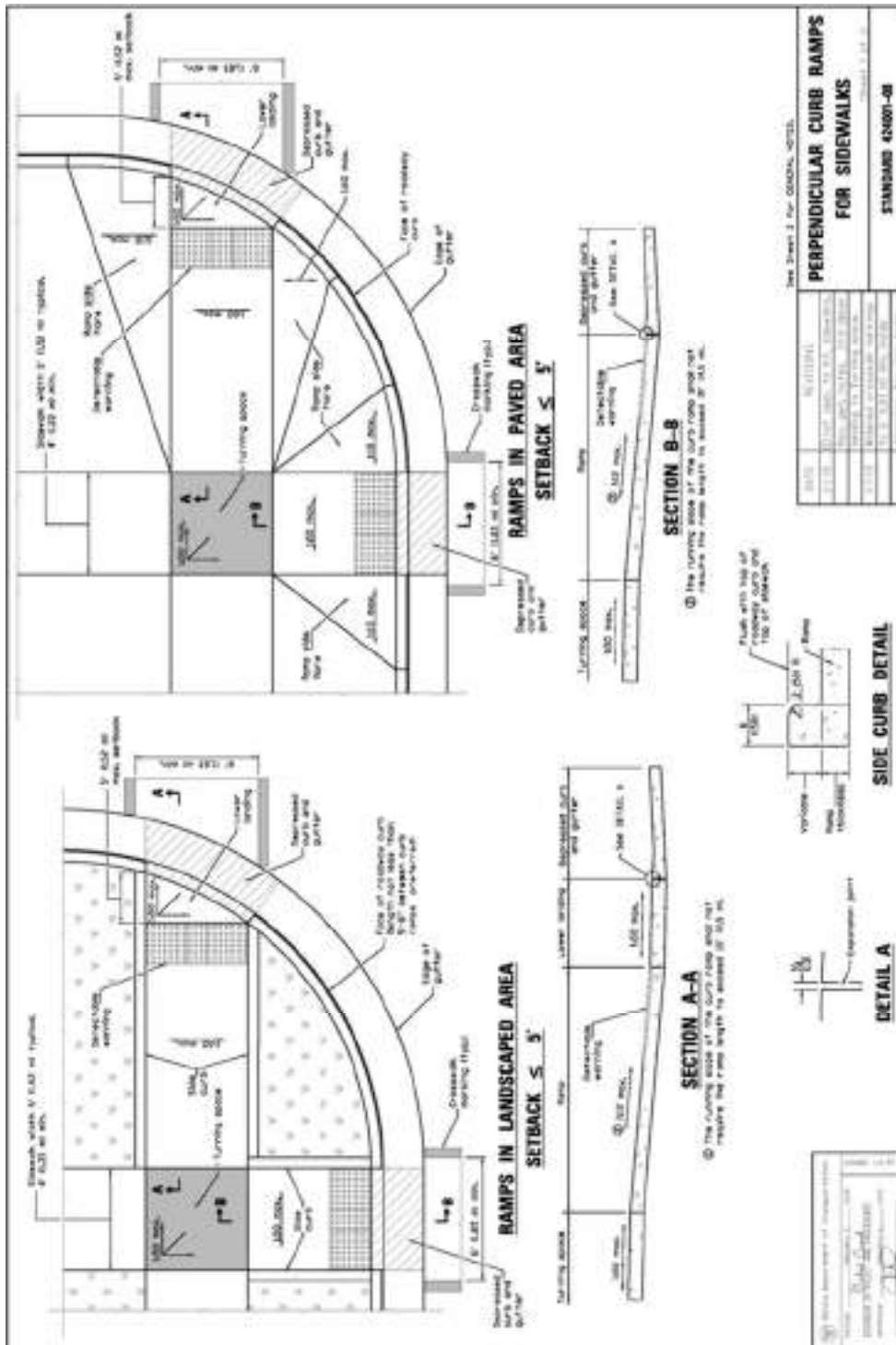
PART 3 – EXECUTION

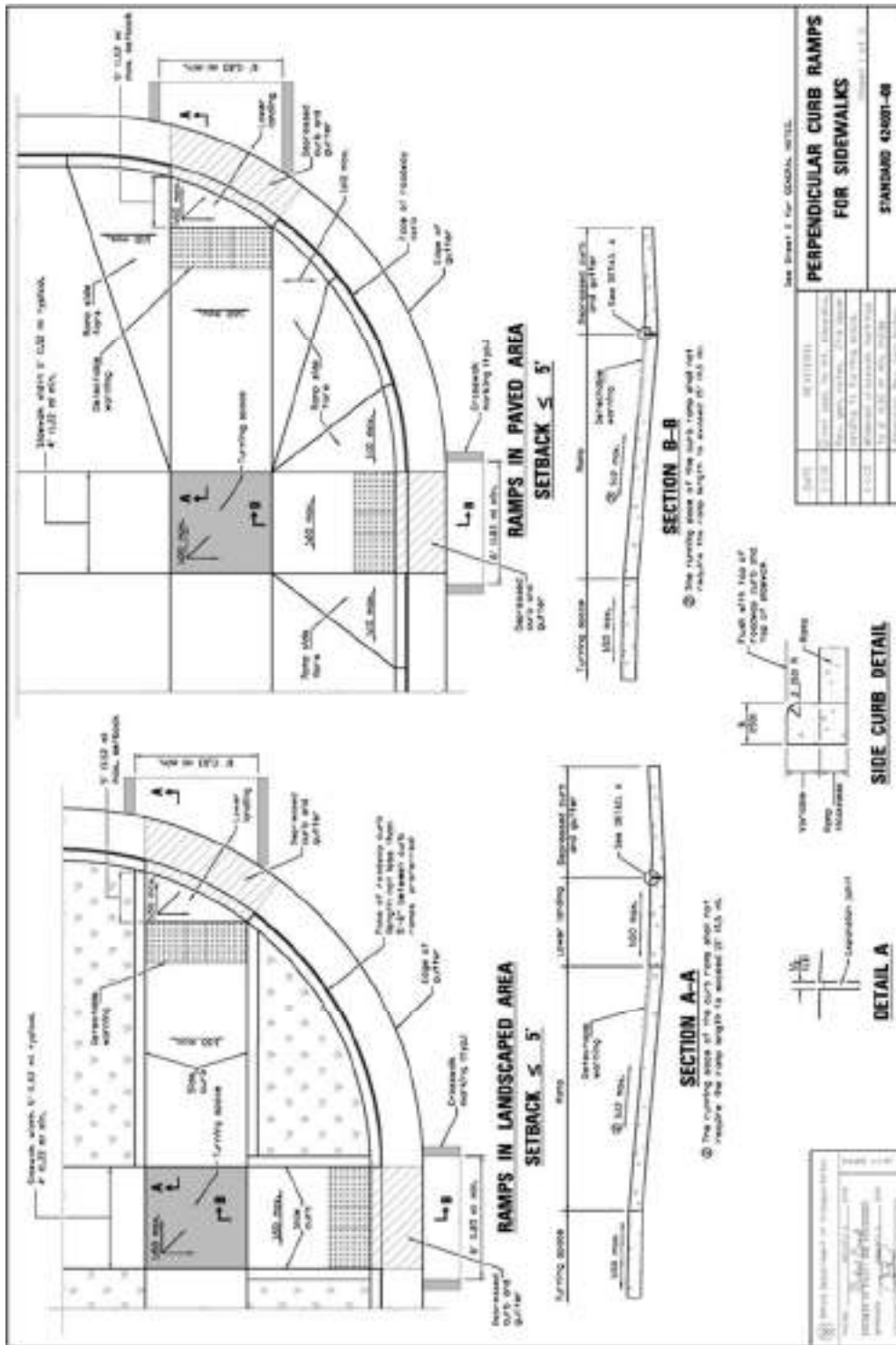
3.1 CURB RAMPS

- A. Sidewalks and curb ramps shall be 6 inches thick and shall be the width indicated on the plans. Cross slopes shall be 2% maximum, unless existing conditions prohibit.
- B. Curb ramps shall be constructed according to the Americans with Disabilities Act Accessibility Guidelines (ADAAG), the Illinois Accessibility Code, and as shown on the plans. The maximum running slope of the ramp shall be 8.3%. The maximum cross-slope shall be 2%. A “landing” shall be provided at the top of each ramp with a maximum cross-slope of 1.5%, for turning or bypassing the ramp. The maximum running slope of sidewalk that precedes a curb ramp shall be 5%
- C. Curb ramps may require a curb poured monolithically along the back or sides of the ramp. The need for curbs shall be determined in the field with the Engineer.

3.2 DETECTABLE WARNINGS

- A. Curb ramps which abut streets shall be provided with a detectable warning surface in accordance with the details in the plans.
- B. The detectable warning surface shall extend 24 inches minimum in the direction of travel and the full width of the curb ramp, landing, or blended transition. The installation shall be an integral part of the walking surface and only the actual domes shall project above the walking surface.
- C. Truncated domes shall be aligned on a square grid aligned in rows parallel and perpendicular to the predominant direction of travel to permit rolling of wheels between the domes. Domes shall not be skewed diagonally to the direction of travel.
- D. Construction of concrete base course beneath the cast iron detectable warning tile shall be in accordance with Section 442 of the Standard Specifications, Portland Cement Concrete Sidewalk and be constructed to a minimum 5 inch depth.





See Sheet 2 for CURB RAMP DETAIL

DATE	REVISION
01/11/11	1
02/11/11	2
03/11/11	3
04/11/11	4
05/11/11	5
06/11/11	6
07/11/11	7
08/11/11	8
09/11/11	9
10/11/11	10
11/11/11	11
12/11/11	12

PERPENDICULAR CURB RAMPS FOR SIDEWALKS
STANDARD 426001-08

END OF SECTION 321600

CURB RAMPS

32 16 00 - 4

SECTION 321713 – PARKING BUMPERS**PART 1 – GENERAL**

1.1 WORK INCLUDES

A. Base Bid:

1. General Contractor Provide:

- a. New 4" high low profile PCC parking bumpers and anchorage.

1.2 RELATED SECTIONS

A. Specified Elsewhere:

1. Section 321216 – Asphalt Paving.
2. Section 321313 – Concrete Paving.
3. Section 321723 – Pavement Marking.

1.3 SUBMITTALS

A. Product Data: Provide unit configuration, dimensions.

B. Samples: Not applicable.

1.4 COORDINATION

A. Coordinate the work with pavement and curb removals, proposed placement and pavement marking.

B. Existing parking blocks are to be removed and returned to Owner if intact, see construction drawings.

PART 2 – PRODUCTS

2.1 CONFIGURATION

A. Nominal Size: 4 inches high, 6 inches wide, 6 feet long.

B. Low Profile Type: Rectangular cross section with sloped vertical faces, square ends.

2.2 ACCESSORIES

A. Asphalt Installation Hardware: Rebar stake with flat head, 5/8 inch diameter and 14 inches long.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Provide units without damage to shape or finish. Replace or repair damaged units.
- B. Install units in parking spaces along the exterior of the parking lot, position center of blocks 2 ft. 6 inches inside the edge of the paving exterior limits.
- C. Fasten units in place with manufacturer's installation hardware, 3 per unit block.
- D. Install units following paving and pavement marking operations.

END OF SECTION 321713

SECTION 321723 – PAVEMENT MARKINGS**PART 1 – GENERAL**

1.1 WORK INCLUDES

- A. Placing painted pavement markings as shown on the plans.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 321216 – Asphalt Paving
 - 2. Section 321313 – Concrete Paving.
 - 3. Section 344116 – Traffic Control Equipment.

1.3 REGULATORY REQUIREMENTS.

- A. Conform to the applicable portions of Section 780 of the Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, latest edition, including all Supplemental Specifications and Recurring Special Provisions, latest edition.
- B. Conform to the Illinois Manual on Uniform Traffic Control Devices, latest edition.
- C. Conform to IDOT's Highway Standards included in the project details of these contract documents.

1.4 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize flagmen, barricades, warning signs, and warning lights as required

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Paint Pavement Marking: Conform to Article 1095.02 of IDOT's Standard Specification.
 - 1. A 4" wide, paint pavement marking will be required for the striping of the parking spaces.
 - 2. Large size (11.5 sq. ft.) paint pavement marking symbols will be required for directional arrows.

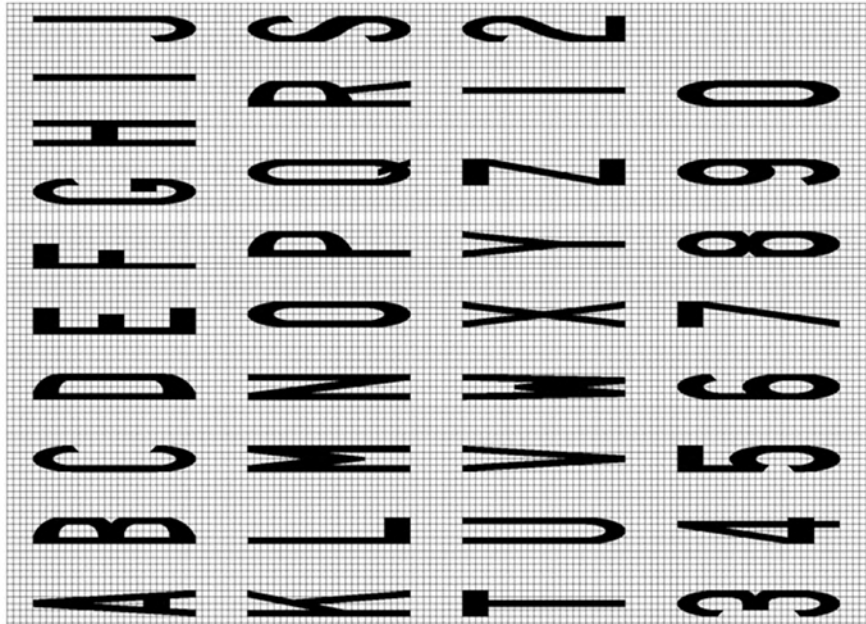
PART 3 – EXECUTION

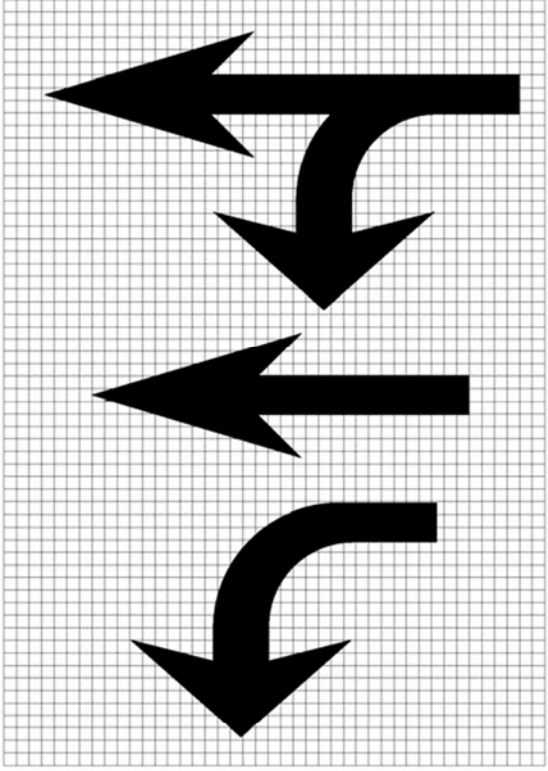
3.1 PREPARATION

- A. Examine the work area and correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
- B. Sweep and clean existing surfaces to be marked to remove all dust, dirt and any debris.
- C. Layout locations for pavement markings for the Engineer to review prior to placement of any new markings.
- D. Verify that sign locations will not conflict with any pavement marking.

3.2 PAINT PAVEMENT MARKING

- A. Furnish and apply paint pavement markings as shown in the plans in accordance with Section 780 of IDOT's Standard Specifications, the Manual on Uniform Traffic Control Devices and IDOT's Highway Standard No. 78001.





Legend Height	Arrow Size	0
6' (1.8 m)	Small	2.9 (74)
8' (2.4 m)	Large	3.8 (96)

The space between adjacent letters or numerals should be approximately 3 (75) for 6' (1.8 m) legends and 4 (100) for 8' (2.4 m) legends.

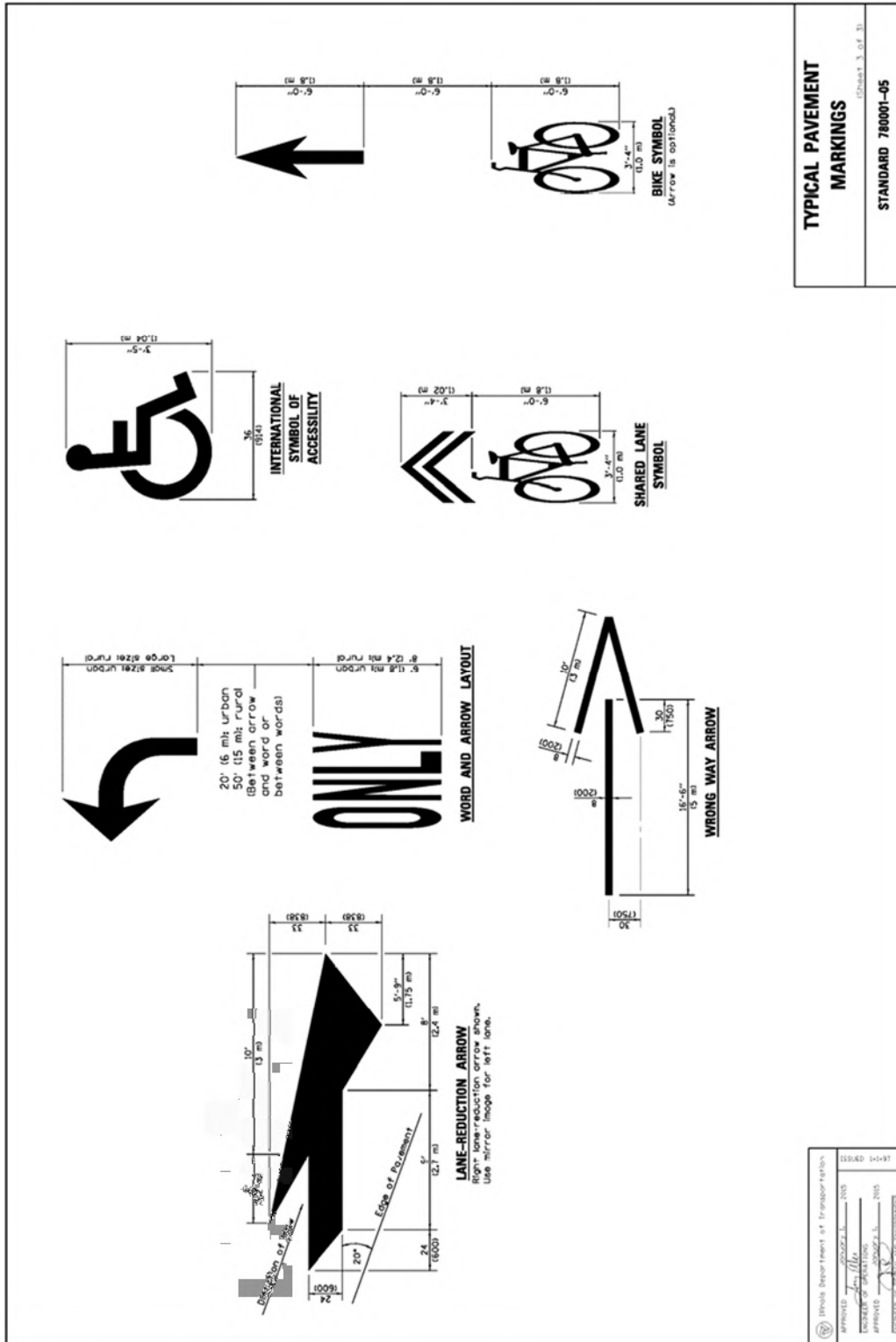
LETTER AND ARROW GRID SCALE

TYPICAL PAVEMENT MARKINGS

(Sheet 2 of 3)

STANDARD 780001-05

ISSUED BY: <i>[Signature]</i> APPROVED BY: <i>[Signature]</i> TITLE: <i>[Title]</i> DEPARTMENT: <i>[Department]</i> DATE: <i>[Date]</i>	ISSUED: 11-17 REVISION: 2005 REVISION: 2005 REVISION: 2005 REVISION: 2005
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TYPICAL PAVEMENT MARKINGS
 (Sheet 3 of 3)
STANDARD 780001-05

Illinois Department of Transportation
 APPROVED: [Signature] DATE: 11-19-97
 CHECKED BY: [Signature]
 APPROVED: [Signature] DATE: 11-19-97
 DESIGNED BY: [Signature]

END OF SECTION 321723

SECTION 32 3215 – CAST-IN-PLACE CONCRETE WALL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes

- 1. Concrete Footing
- 2. Concrete Wall

B. Related Requirements

- 1. All exterior work specifications

1.3 DEFINITIONS

- A. Illinois Department of Transportation Standard Specification for Roads and Bridge Construction, latest edition as amended, referred herein as IDOT Standard Specifications.

1.4 ACTION SUBMITTALS

A. Product data

- 1. Proposed concrete mix
- 2. Concrete test data

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years minimum experience in concrete forming and pouring. The personnel of the firm are to be experienced in the work specified and work under the direction of a foreman with 3 years minimum experience.
- B. Contractor is responsible to protect and avoid all existing above ground and underground utilities during construction operations. Repair of any utilities damaged by construction shall be the responsibility of the Contractor.
- C. Contractor is responsible to protect all existing conditions including structures, pavement and plant material from damage during construction. Any damages occurring shall be the responsibility of the Contractor to replace, repair or compensate the Owner for damages.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle to prevent damage to the products and materials.

PART 2 – PRODUCTS

2.1 PRODUCTS AND MATERIALS

A. Concrete for Footings and Wall

1. In accordance with Section 1020 - Portland Cement Concrete, Type SI, IDOT Standard Specifications.
2. Concrete aggregates conforming to ASTM C-33. The maximum size aggregate to be 1/5 of the narrowest dimension between sides of forms, 3/4 of the minimum clear distance between reinforcing bars, or 1/3 of the depth of slabs.
3. Water used in mixing concrete to be free from sewage, oils, acids, alkalis, salts, organics, or other deleterious materials. Water approved by Public Health Agencies for drinking may be accepted without being tested.

B. Rebar: According to project plans and Section 1006 – Metals, IDOT Standard Specifications.

C. Acrylic Sealer: Minimum 20% solids as recommended by manufacturer of masonry unit products.

D. Aggregate: CA-6 and CA-7 crushed stone meeting the requirements of Section 1004 – Coarse Aggregate, IDOT Standard Specifications.

PART 3 – EXECUTION

3.1 INSTALLATION, GENERAL

A. According to Section 321315 – Special Concrete and related specifications.

3.2 EXCAVATION

A. Excavate to dimensions needed for construction of footings and foundations. Soil at base of excavation to be undisturbed and compact. Ground found to be soft or to contain foreign material such as roots or debris to be over-excavated. Lifts of soil to be compacted as directed by and to the satisfaction of the Owner's Representative.

3.3 FOOTINGS, FOUNDATIONS AND WALLS

A. Place CA6 on sub-grade and compact to 95% density.

B. Securely set forms in place.

C. Secure reinforcement and tie in place.

D. Pour concrete and use vibrating devices to eliminate air pockets.

E. Cover and protect pours during curing.

F. Carefully hand-rub all exposed surfaces with a stone and mortar slurry to remove burs and small voids and produce a smooth and even surface.

END OF SECTION 32 3215

SECTION 32 3253 – STONE RETAINING WALLS

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. Ledge stone and incidentals
- B. Related Requirements
 - 1. All exterior improvement work

1.3 DEFINITIONS

- A. The Illinois Department of Transportation Standard Specifications for Road and Bridge Construction, adopted January 1, 2016 and all subsequent amendments, referred herein as IDOT Standard Specifications.

1.4 ACTION SUBMITTALS

- A. Product Information and Samples
 - 1. Product information for wall stone
 - 2. Three full size samples of wall stone
 - 3. Cut sheet for geotextile

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years' experience in similar work. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor is responsible to protect and avoid all existing underground and above ground utilities during construction operations. Repair of any utilities damaged by installation is the responsibility of the Contractor.
- C. Contractor is responsible to protect all existing conditions including structures, pavements, and plant material from damage during project installation and maintenance. Any damages occurring are the responsibility of the Contractor to replace, repair or compensate Owner for damages.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle to prevent damage to the products and materials.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Ledge Stone

1. Random length limestone, 8-12" deep, 3-5" thick in a mixture of buff, gold, tan, and gray tones. Stone to cover 20 face feet per ton.
2. Stone to be one of the following:
 - a. Kodiak Wallstone Collection, quarried by Halquist Stone, Sussex, WI 53089, 262-246-900, www.halquiststone.com.
 - b. EW Gold Random Drywall, 3-5" thick, quarried by Earthworks Inc., 4287 N. Highway 51, Perryville, MO 63775, 573-547-9097, www.ewgroupinc.com.
 - c. Northern Rustic Cut Drywall, quarried by Rademann Stone & Landscape Co. Inc., W5551 County Road B, Fond du Lac WI 54937, 920-922-7612, www.rademann.com.
 - d. Equal as approved by UIS Facilities.

B. Aggregate: CA-6 and CA-7 crushed stone meeting the requirements of Section 1004 Coarse Aggregate, IDOT Standard Specifications.

C. Filter fabric: 6 oz. weight non-woven fabric meeting standards of Section 282. Filter Fabric, IDOT Standard Specifications.

D. Staples for filter fabric: 11 gauge, "U" shaped with approximately 2 inches at the top and 6 inch legs.

E. Adhesive: Masonry adhesive for outdoor use.

PART 3 – EXECUTION

3.1 PREPARATION

A. Determine the location of all utilities at the site.

B. Stake location of wall for review by Landscape Architect.

C. Provide safeguards to protect improvements including structures, pavements and plant material.

3.2 STONE WALL INSTALLATION

A. Excavation

1. Excavate soil to required lines and grades.
2. Compact soil if area has been filled.

B. Base Preparation

1. Lay geotextile fabric according to plan on undisturbed or compacted sub-grade.
2. Place CA-6 and thoroughly hand tamp to compact to form a 4" base.

C. Stone Setting (dry laid)

1. Set stone with not less than 6" of the first course below finish grade.
2. Set courses with combinations of stone thickness layered and integrated to achieve random appearance.
3. Offset each course approximately 1" behind the course below to result in a back slope on the

- wall face.
4. Backfill with CA-7 behind the wall and hand tamp as the wall is set. Maintain geotextile separation between the aggregate and soil backfill.
 5. Backfill with approved topsoil behind the CA-7 and geotextile fabric as the wall is set, and thoroughly hand tamp. Maintain geotextile separation between the wall and backfill.
 6. Layout Top Course
 - a. Use large stones (4-5" thickness) with relatively square ends.
 - b. Butt-up ends as tightly as possible.
 - c. Pitch top surface to drain.
 7. Set Top Course
 - a. Set top course with adhesive.
 - b. Clean any adhesive squeeze-out so that no adhesive is visible.
 8. Fold geotextile and secure 6" of finish grade.
 9. Place min. 6" topsoil and hand tamp to finish grade as shown on plan.

END OF SECTION 32 3253

SECTION 32 9219 – TURF SEEDING

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. Seedbed Preparation
 - 2. Fertilizer, Pre-seed
 - 3. Turf Seed
 - 4. Mulch
 - 5. Transitional Erosion Control Mat
 - 6. Turf Reinforcement Mat
 - 7. Fertilizer, Post-seed

- B. Related Requirements
 - 1. All exterior improvement work

1.3 DEFINITIONS

- A. The Illinois Department of Transportation Standard Specifications for Road and Bridge Construction, adopted January 1, 2016 and all subsequent amendments, referred herein as IDOT Standard Specifications.

1.4 ACTION SUBMITTALS

- A. Prior to commencing work
 - 1. A list of equipment anticipated for use
 - 2. Proposed seed source
 - 3. Any proposed deviation from specified seed mix
 - 4. Illinois Applicator's License for anyone who might apply herbicide at the site
- B. Upon completion of work
 - 1. Tags from all bags of seed and fertilizer used at the site, certifying composition and weight

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years experience in seeding of similar sites. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor personnel engaged in herbicide application shall have an Illinois Applicator's License.
- C. Contractor is responsible to protect and avoid all existing above ground and underground utilities

during construction operations. Repair of any utilities damaged by installation is the responsibility of the Contractor.

- C. Contractor is responsible to protect all existing conditions including structures, pavement and plant material from damage during construction. Any damages occurring are the responsibility of the Contractor to replace, repair or compensate Owner for damages.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Raise all packaged products above the ground and thoroughly covered with polyethylene to minimize moisture absorption if stored on the site.

PART 2 – PRODUCTS

2.1 PRODUCTS AND MATERIALS

A. Pre-seed Fertilizer

1. Nutrients: Commercial nitrogen, phosphorus and potassium mixed in a 1:1:1 ratio of active ingredients and applied at a rate that will yield 1 lb. nitrogen per 1,000 sq. ft. (1/3 to 1/2 of the nitrogen is to be slow release).
2. Premixed in sacks each bearing a tag with the following information clearly printed: name and address of manufacturer, brand, weight, chemical composition and guarantee of analysis.

B. Post-seed Fertilizer

1. Nutrients: Commercial slow-release nitrogen, phosphorus and potassium mixed in a 2:1:1 ratio of active ingredients and applied at a rate which will yield 1 lb. nitrogen per 1,000 sq. ft. (1/3 to 1/2 of the nitrogen is to be slow release).
2. Premixed in sacks each bearing a tag with the following information clearly printed: name and address of manufacturer, brand, weight, chemical composition and guarantee of analysis.

C. Turf Grass Seed

1. Seed mix

* Turf-Type Fescue – 200 lbs./acre: mixture of three or more of the following varieties with one variety being a rhizomatous tall fescue (RTF): Labarinth (RTF) Tall Fescue, Barrington Tall Fescue and Barrera Tall Fescue.

** Blue Grass – 20 lbs./acre: one or more of the following varieties: Barrister, Chateau, Destiny, Enmundi, Gnome, Marquis, and Suffolk.

*** Rye Grass – 20 lbs./acre: mixture of three or more of the following varieties: All Star, Caddie, Caliente, Dasher II, Diplomat,, Pennant, and SR 4000.

**** Creeping Red (Fine) Fescue – 20 lbs./acre: either Dawson or Pennlawn.

Note: Contractor may propose alternate varieties, selected for their drought-hardiness, insect and disease resistance, good color and low-growth character.

2. Species and variety true to label with quantity/quality information listed below. Should the pure live seed be less than required herein, increase seeding rate to obtain an equal amount of pure live seed per acre. Seed to contain no noxious weed seeds and no more than 2% total inert/other crop seeds.

3. Premixed in sacks each bearing a tag with the following information clearly printed: date and location of packaging, seed mixture, percentage of pure live seed, year of production and weight.
- D. Straw: Fresh clean straw free from weeds, seeds and foreign materials that may hinder good turf development.
- E. Hydro-mulch: Cellulose manufactured specifically for said purpose. Mulch shall be free from foreign material and sized appropriately to be applied at specified rates.
- F. Transitional Erosion Control Mat: 100% UV stabilized natural rubber mat with surface texture and holes to allow for vegetative growth through the openings. Mat is mechanically anchored to be used as a biotechnical replacement for hard armor. Soil anchors according to manufacturer's specifications.
- G. Turf Reinforcement Mat: UV stabilized top, center, and bottom nets with a 70% straw, 30% coconut fiber matrix. Soil anchors according to manufacturer's specifications
- H. Water for hydro-mulch: Clean water, free from chemicals and materials which would adversely affect germination and growth of seeds.

PART 3 - EXECUTION

3.1 EXISTING TOPSOIL

- A. Site is to have not less than 12" depth of good topsoil over all areas to be seeded.

3.2 EXISTING PLANT GROWTH

- A. Remove and dispose of all existing turf or other vegetation over areas to be seeded.

3.3 TURF LAWN SEEDING

A. Time of Operations

1. Commence operations after giving a minimum 24 hours' notice to Landscape Architect and receiving approval.
2. Prepare seedbed and seed when soil is relatively dry and friable to avoid clodding or compacting of soil.
3. Seeding dates unless otherwise authorized.
 - a. Spring seeding: as early in spring as conditions allow and no later than April 30.
 - b. Fall seeding: between August 15 and September 31.

B. Seedbed Preparation

1. Till areas designated for seeding to a minimum depth of 4 inches.
2. Remove all roots, sticks, weeds, stones, etc. larger than 1 inch in dimension. Dispose of off-site.
3. Remove all foreign material including construction waste, litter and contaminating products. Dispose of off-site.
4. Soil clods to be no greater than 2" in any dimension.

5. Verify all areas drain away from buildings and sidewalks.
- C. Pre-seed Fertilizing
1. Within 24 hours of seedbed preparation, fertilize area with 1 lb. nitrogen per 1,000 sq. ft. using Pre-seed Fertilizer.
- D. Seeding
1. Seed into freshly prepared seed bed. If the seed bed is crusted-over or damaged, re-prepare seedbed prior to seeding.
 2. Alternative seeding methods, use separately or in combination
 - a. Drilling
 - 1) Drill seed into soil at proper depth.
 - 2) Drill using a minimum two (2) passes at right angles to each other.
 - b. Broadcasting
 - 1) Uniformly broadcast seed over the prepared seedbed.
 - 2) Rake or drag seedbed to incorporate seed in the top 1/2 inch soil.
- E. Mulch
1. Use either straw or hydro mulch over seeded areas.
 - a. Straw mulching
 - 1) Uniformly cover area with straw at the rate of 1-1/2 tons per acre.
 - 2) Punch straw into the soil with an uncambered dull disk approximately 20 inches in diameter set at 3-inch intervals. Use stabilizer weights needed to push into the ground at least 2 inches.
 - 3) In areas inaccessible to mechanical punching, apply water to the spread straw at a rate and duration to bind the straw.
 - 4) Clean-up straw blown beyond the seeded areas.
 - b. Hydromulching
 - 1) Hydro-mulch at the rate of 750 pounds of cellulose mulch per acre. Mix mulch with water and apply at the rate of 1000 gallons per acre.
 - 2) Do not mix seed with the hydro-mulch.
 - 3) Protect building, sidewalks and other improvements during hydro-mulching operations.
 - 4) Clean-up any mulch blown beyond the seeded area.
 2. Use transitional erosion control mat and turf reinforcement mat at culvert outlet and runnel locations as indicated on project plans.
 - a. Turf reinforcement mat
 - 1) Place blanket over prepared and seeded surface.
 - 2) Trench-in edges according to project plans and manufacturer's instructions.
 - 3) Secure with anchor pins according to manufacturer's instructions.

- b. Transitional erosion control mat
 - 1) Install mat over turf reinforcement mat according to manufacturer's instructions.

3.3 TURF MAINTENANCE

- A. Maintain seeded areas for a minimum of 60 days or until final project approval, whichever is longer.
 - 1. Watering
 - a. Water seeded areas to achieve a rate of 5 gallons per square yard every 2 days until established. Rainfall may relieve the need for watering at certain times.
 - b. Water in a manner to achieve infiltration of water and avoid run-off and soil erosion.
 - c. Supply hoses and other equipment needed.
 - d. Water is available on-site.
 - 2. Mowing
 - a. Mow seeded areas including edges around the driveways, sidewalks and mulched areas.
 - b. Mow with reel-type or rotary-type mowers, edgers, etc. with sharp blades set level. Mowed areas shall be smooth and uniform in height.
 - c. Mow when the grass is relatively dry and ground is firm.
 - d. Mow when growth reaches a height of 5 inches. Cut to a height of 3 inches. If Contractor delays result in excess turf growth prior to mowing, Contractor must also rake and remove cuttings from the site.
 - 3. Post-seed Fertilizing
 - a. Thirty (30) days following the first mowing, re-fertilize turf areas at the rate of 1 lb. nitrogen per 1,000 sq. ft. using Post-seed Fertilizer.
 - 4. Weeding
 - a. Keep areas free of weed growth.
 - 5. Treatments
 - a. Treat turf for insects, disease, fungus, or other adverse conditions that develop. Discuss conditions with Landscape Architect and agree to an appropriate treatment. Provide treatment following good horticultural practices and product manufacturer's guidelines.
 - 5. Reseeding (if necessary due to unsuccessful establishment)
 - a. If seed does not germinate and develop into healthy turf or seed is washed away or soil erodes before successful establishment, Contractor shall re-seed following these seeding specifications, over-seed or otherwise provide remedial work necessary for successful turf development as directed by Landscape Architect. Reseeding during the installation period prior to initial project approval is not considered part of the warranty work. After project approval, re-seeding will be covered under the seed warranty.

END OF SECTION 32 9219

SECTION 32 9220 – PRAIRIE SEEDING

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. Seedbed Preparation
 - 2. Seeding
 - 3. Mulching
 - 4. Mowing
 - 5. Excelsior Blanket
- B. Related Requirements
 - 1. All exterior improvement work

1.3 DEFINITIONS

- A. The Illinois Department of Transportation Standard Specifications for Road and Bridge Construction, adopted January 1, 2016 and all subsequent amendments, referred herein as IDOT Standard Specifications.

1.4 ACTION SUBMITTALS

- A. Prior to operations
 - 1. Schedule of seeding
 - 2. Source of seed, proposed seed mixes
 - 3. Herbicides and application techniques
- B. During operations
 - 1. Tags from seed bags certifying source, composition and quantity
 - 2. Tags from fertilizer bags certifying composition
 - 3. Load tickets from straw mulch

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years experience in seeding of similar sites. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor personnel engaged in herbicide application shall have an Illinois Applicator's License.
- C. Contractor is responsible to protect and avoid all existing underground utilities during construction

operations. Repair of any utilities damaged by installation shall be the responsibility of the Contractor.

- D. Contractor is responsible to protect all existing conditions including buildings, fences, pavements, trees, and other plant material from damage during project installation and maintenance. Any damages occurring shall be the responsibility of the Contractor to replace, repair or compensate Owner for damages.

1.6 WARRANTY

Contractor shall warranty turf for one complete growing season. If seed does not germinate and develop into healthy turf, Contractor shall reseed following these seeding specifications, overseed or otherwise provide remedial work necessary for successful turf development as directed by Landscape Architect.

Successful Establishment shall be achieved when

1. 100% of the grass species and minimum 20% of the forb species planted are established, and
2. When there are a minimum of 40 stems per square yard of planted prairie seeds.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Starter Fertilizer nutrients shall be commercial nitrogen, phosphorus and potassium mixed in a 1:1:1 ratio of active ingredients and applied at a rate which will yield the number of actual nutrient pounds per acre as required.
- B. Maintenance Fertilizer nutrients shall be commercial slow-release nitrogen, phosphorus and potassium mixed in a 2:1:1 ratio of active ingredients and applied at a rate which will yield the number of actual nutrient pounds per acre as required.
- C. Seed Mixes shall be those shown on plans. Contractor may propose alternate varieties with equal or better qualities.
- D. Straw shall be fresh clean straw free from weed seeds, and foreign material.
- E. Hydro-mulch shall be cellulose manufactured specifically for said purpose. Mulch shall be free from foreign material and sized appropriately to be applied at specified rates.
- F. Water for hydro-mulch shall be clean water, free from chemicals and materials which would adversely affect germination and growth of seeds.
- G. Excelsior Blanket shall be a wood fiber erosion control blanket, covered one side (only) with plastic mesh netting. Blanket shall be approximately 60 inches wide, 150 feet long, weighing 0.8 pounds per square yard.
- H. Staples for Excelsior Blanket shall be 11 gauge, "U" shaped with approximately 2 inches at the top and 6-inch legs.

2.2 DELIVERY AND STORAGE

- A. Grass seed shall be delivered premixed in sacks each bearing a tag with the following information clearly printed: date and location of packaging, seed mixture, percentage of pure live seed, year of production and weight.

- B. Fertilizer may be delivered separately or premixed in sacks in which case each sack shall bear a tag with the following information clearly printed: name and address of manufacturer, brand, weight, chemical composition and guarantee of analysis.
- C. If the fertilizer, seed or mulch is stored on the site, it shall be raised above the ground and thoroughly covered with polyethylene to minimize moisture absorption.

2.3 CONDITION OF SITE

- A. No topsoiling is required for areas to be seeded with temporary seed mix.
- B. Site shall be finish graded to the lines and grades shown on plans and all areas shall drain.

PART 3 – EXECUTION

3.1 PRAIRIE SEEDING

A. Time of Operations

1. Contractor shall commence operations only after giving a minimum 24 hours notice to Landscape Architect.
2. Seedbed preparation and seeding shall be done only when soil is relatively dry to avoid clodding and compaction of soil.
3. Seeding Dates
 - a. Spring seeding shall be from May 15 through June 15
 - b. Dormant seeding may be allowed on October 15 and until ground freezes.

B. Seedbed Preparation

1. All areas designated for seeding shall be tilled to a minimum depth of 4 inches or, where no grading is required, treated with herbicide to kill weeds as directed by Landscape Architect.
2. Surface shall be free of all construction debris, vegetative debris and litter.
3. Soils particles shall be no larger than one inch in dimension.
4. Landscape Architect will approve seed bed prior to seeding. Seed beds will not be approved where living weeds or vegetative growth remains.

C. Fertilizing

1. No fertilizing is required.

D. Seeding

1. Seeding shall be done into freshly prepared and rolled seed bed.
 - a. If the seed bed has been compacted, crusted-over, or otherwise affected, seedbed shall be re-prepared prior to seeding.
 - b. If any germination or growth is showing on seed bed, Contractor shall treat with herbicide to kill plants and remove above-ground growth.
2. Seeding shall be done by one of these methods.
 - a. Uniformly broadcasting over the surface and lightly dragging to set the seeds into the soil.

- b. Drilling with specialized equipment set to the proper depth for each type and size seed.
 - E. Mulch
 - 1. Mulch may be required.
 - F. Watering
 - 1. Contractor is not required to water seeded areas but may elect to do so to optimize germination and successful establishment of turf. Seeded areas generally shall be watered to achieve a rate of 5 gallons per square yard every 2 days until established. Rainfall may relieve the need for watering at certain times.
 - 2. Watering shall be done in a manner to achieve infiltration of water and avoid run-off and soil erosion.
 - 3. Contractor shall supply hoses, portable sprinkling devices and other needed equipment to provide supplemental watering when needed.
 - 4. Water will be available on-site.
 - G. Mowing
 - 1. Contractor shall provide mowing three (3) times at times to retard weed development and seeding at times determined by Landscape Architect.
 - 2. Contractor shall cut the turf with a rotary-type mowers to a height of 8-10 inches or as otherwise directed.
- 3.2 EXCELSIOR BLANKET
- a. Excelsior blanket may be required.
- 3.3 ESTABLISHMENT
- A. Contractor shall maintain seeded area until acceptance of project or successful establishment of not less than 3 months, whichever is longer.
 - B. During the establishment period, Contractor shall provide
 - 1. Treatment of Insects, Disease, Fungus
 - a. Should problems with the turf develop such as insect infestation, disease or fungus, Contractor shall immediately notify the Landscape Architect and discuss remedies available.
 - b. Contractor shall proceed expeditiously with selected treatment of affected areas and continue treatment until the problem is resolved. Contractor shall have state licensed applicators for treatment products as needed.

END OF SECTION 32 9220

SECTION 32 9225 - WETLAND DEVELOPMENT

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. Wetland species seed and installation
 - 2. Wetland plugs and installation
 - 3. Reinforced turf mat
 - 4. Goose netting
- B. Related Requirements
 - 1. All exterior improvement work

1.3 DEFINITIONS

- A. U.S.D.A. Standards for Nursery Stock, American Association of Nurserymen.
- B. Standardized Plant Names, American Joint Committee on Horticulture Nomenclature.

1.4 ACTION SUBMITTALS

- A. Prior to operations
 - 1. Sources of seed and plant material
- B. During operations
 - 1. Tags from sed mix bags

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years' experience in similar work. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor personnel engaged in herbicide application shall have an Illinois Applicator's License.
- C. Contractor is responsible to protect and avoid all existing underground and above ground utilities during construction operations. Repair of any utilities damaged by installation shall be the responsibility of the Contractor.

- D. Contractor is responsible to protect all existing conditions including buildings, fences, roadways, driveways, sidewalks, trees, and other plant material from damage during project installation and maintenance. Any damages occurring shall be the responsibility of the Contractor to replace, repair or compensate Owner for damages.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Plant material shall be delivered to the site within 48 hours of its scheduled installation.
- B. All Plant Material shall be transported and handled to avoid physical damage and desiccation of the plants. Protective covering shall be used during shipment.
- C. At the site plants shall be kept in the shade and protected from weather and mechanical damage. Roots shall be kept moist. The name of one plant of each variety shall be clearly marked.
- D. All packaged material shall be delivered in containers showing the weight, analysis and name of manufacturer. Material shall be protected from deterioration during delivery and storage at the site.
- E. During installation, material shall be handled to avoid damage to all plant parts. Should any plant parts be accidentally damaged during operations, the Landscape Architect shall decide if immediate replacement is required.

1.7 WARRANTY

- A. Contractor shall warranty for one year from acceptance all material and work in this project, and provide one replacement if necessary in accordance with these plans and specifications. If at any time during this year a plant dies, becomes diseased or unsightly, the Landscape Architect may request immediate or future replacement and the Contractor shall promptly comply.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Wetland seed mix as shown on drawings.
- B. Plugs shall be well-developed in plug trays with cells 4.75 inch depth, 2.25 inch top diameter.
- C. Reinforced turf mat shall be nondegradable Vmax3 C350, 3 dimensional composite turf reinforcement mat supplied by North American Green, 14649 Highway 41 North, Evansville, IN 47725 (p) 800-772-2040. www.nagreen.com
- D. Staples for reinforced turf mat shall be 11 gauge, "U" shaped with approximately 2 inches at the top and 6 inch legs.
- E. Goose netting shall be black, UV protected polypropylene with openings no greater than 1".
- F. Water will be available at the site. Contractor to provide all necessary hoses, watering apparatus, labor, etc. to water according to these specifications.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Determine the location of all utilities at the site.
- B. Stake work area perimeters. Notify Landscape Architect and provide time to inspect the staking and make adjustments before operations begin.
- C. Provide safeguards to protect structures, roads, walkways, etc. from possible damage during operations.

3.2 EXISTING VEGETATION

A. Woody vegetation

- 1. Treat and remove woody vegetation (trees, shrubs, vines) as shown on plans, as follows.
 - a) Cut plant flush with the ground.
 - b) Spray or brush cut surface immediately with herbicide to kill the plant.
 - c) Remove cut vegetation from the site.
 - d) Re-cut and re-treated any new growth according to these specifications or as directed by Landscape Architect. Note: proper initial treatment will virtually eliminate the need to re-treat.

B. Herbaceous vegetation

- 1. Cut at ground level and remove cut material.

3.3 WETLAND SEED PLANTING

- A. Seed wetland area according to Prairie Seeding specification 329220.

3.4 PLANTING – EMERGENT PLANT PLUGS

A. Time of Operation

- 1. Planting shall be between April 1 and September 1 when the climatic and soil conditions and water level are appropriate as confirmed by Landscape Architect.

B. Reinforced Turf Mat

- 1. Reinforced turf mat shall be laid in locations shown on plan and as directed by Landscape Architect.
- 2. Mat shall be installed according to plan and manufacturer's recommendations including the following:
 - a. Mat shall be installed with exposed edges buried in the ground as shown on plans.
 - b. Mat shall be stapled in place on approximate 3-foot intervals in staggered rows.
 - c. Edges shall be overlapped by 2-3 inches and stapled in 1.5-foot intervals.

C. Bed Preparation

1. Any existing vegetation shall be killed using a systemic herbicide such as Round-up.
2. Near water bodies, Rodeo or other approved aquatic-safe glyphosate formulation shall be used.
3. Dead vegetation shall be cut within 4" of ground and removed.

D. Planting

1. Follow planting operations in Section 329300, with the following exceptions
 - a. Plugs shall be set in the ground at the same level at which they were grown and soil shall be pinched-in to cover the roots.
 - b. Plugs shall be planted in reinforced turf mat by slicing the blanket to the extent needed to plant the plug.

E. Goose Netting

1. Install netting
 - a. Four foot long oak stakes shall be driven securely into the ground 3' on center in the plug planting areas.
 - b. Goose netting shall be stapled securely around the edges of planted areas. Over the top, goose netting can be secured or plastic taping can be wrapped from stake to stake to form a grid over the areas.

3.5 MAINTENANCE

A. Carefully monitor the condition of planted area through the 1-year warranty period and provide

1. Treatment of Insects, Disease, Fungus
 - a. Should problems with the plant material develop such as insect infestation, disease or fungus, Contractor shall immediately notify the Landscape Architect and discuss remedies available.
 - b. Contractor shall proceed expeditiously with selected treatment of affected areas and continue treatment until the problem is resolved.
 - c. Contractor shall have state licensed applicators for treatment products as needed.

END OF SECTION 32 9225

SECTION 32 9230 - REFORESTATION

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. Provide and install seedlings and grow tubes
 - 2. Apply herbicide
 - 3. Maintenance Related Requirements
- B. Related Requirements
 - 1. All exterior improvement work

1.3 DEFINITIONS

- A. U.S.D.A. Standards for Nursery Stock, American Association of Nurserymen
- B. Standardized Plant Names, American Joint Committee on Horticulture Nomenclature

1.4 ACTION SUBMITTALS

- A. Prior to operations
 - 1. Source(s) of seedlings
- B. During operations
 - 1. Tags from all seedling bundles showing species, quantity, size and source

1.5 QUALITY ASSURANCE

- A. All work described in this Section is to be done by a firm specializing in such work with documented 5 years experience in similar work. The personnel of the firm shall be experienced in the work specified and shall work under the direction of a skilled foreman.
- B. Contractor personnel engaged in herbicide application shall have an Illinois Applicator's License.
- C. Contractor is responsible to protect and avoid all existing underground and above ground utilities during construction operations. Repair of any utilities damaged by installation shall be the responsibility of the Contractor.
- D. Contractor is responsible to protect all existing conditions including buildings, fences, roadways, trees, and other plant material from damage during project installation and maintenance. Any

damages occurring shall be the responsibility of the Contractor to replace, repair or compensate Owner for damages.

1.6 DELIVERY, STORAGE AND HANDLING

A. Seedlings

1. Deliver to the site within 48 hours of scheduled installation.
2. Transport and handle to avoid physical damage and desiccation.
3. Use protective cover during shipment.
4. Keep in shade and protect from weather and mechanical damage.
5. Every bundle shall be labeled with the species name and quantity.

B. Packaged material: Deliver in containers showing the weight, analysis and name of manufacturer. Protect from deterioration during delivery and storage at the site.

C. Seedlings, during installation

1. Keep roots t moist until planted.
2. Handle to avoid damage to all plant parts.

1.7 WARRANTY

- A. Contractor shall warranty for one year from acceptance all material and work i n this project, and provide one replacement if necessary, in accordance with these plans and specifications. At the end of the 1-year warranty period, if more than 10% of the seedlings in any planting zone (as delineated on plans) have not survived, Contractor shall replace all dead seedlings in that zone.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Seedlings shall:

1. Be a minimum 2 years old, either container grown or 2-1 (2 years old / 1 lifting).
2. Have a height of 18 to 24 inches and root collars a minimum 7/32" (0.22 inches) diameter unless otherwise noted on plan.
3. Conform to the species and sizes specified.
4. Be clearly marked as to source, species and variety.
5. Be first quality stock with well developed tops and roots.
6. Be free from diseases, insect pests and injuries.
7. Be approved by the Landscape Architect prior to installation.

B. Growing tubes shall be double-wall plastic Grow Tubes or equal, the length of the seedling.

C. Herbicide shall be a non-specific glyphosate weed killer such as Roundup.

D. Water will be available at the site in detention ponds and from irrigation system (part of this project). Contractor shall provide all necessary hoses, watering apparatus, labor, etc. to water according to these specifications.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Contractor shall determine the location of all utilities at the site.
- C. Contractor shall set stakes at intervals and run twine to establish planting lines.
- D. Landscape Architect shall be notified and provided an opportunity to inspect the staking prior to planting operations.

3.2 SEEDLING PLANTING

A. Time of Operation

- 1. Planting shall be between when the climatic and soil conditions are appropriate as confirmed by Landscape Architect and according to the following schedule.
 - a. SPRING PLANTING: between April 1 and May 31

B. Installation

1. Preparation

- a. Prior to planting of seedlings, area shall be seeded according to Section 02936 – Seeding. During planting operations, care shall be taken not to damage developing turf.
- b. If planting into established turf, a 12” diameter planting area shall be sprayed with herbicide. Landscape Architect shall determine if herbicide preparation is necessary.

2. Planting

- a. Trees may be planted by either
 - 1) Excavating with spades or planting bars. Depth shall be a minimum 8” deep, or
 - 2) Use of a mechanical tree planter. Planter shall be set to provide an 8” depth slit.
- b. Roots shall be carefully untangled. Roots may be trimmed to min. 8” length, except tap roots shall not be cut.
- c. Roots shall be placed into opening keeping roots straight, not wadded or twisted.
- d. Seedling shall be placed at root collar, the level originally grown.
- e. Soil shall be tamped or firmly pressed by mechanical planter over root mass.

4. Watering

- a. Each plant shall be watered no more than 2 hours after planting with 1-2 gallons of water.
- b. Watering shall continue as needed for successful establishment of seedlings, see maintenance.

5. Growing Tubes

- a. Contractor shall install growing tubes around seedlings for protection from browsing and other damage.
- b. Tubes shall be carefully placed over the stems.

3.3 MAINTENANCE

- A. Contractor shall carefully monitor the condition seedlings through the 1-year warranty period. During this maintenance period, Contractor shall provide:
 1. Watering
 - a. Watering shall continue as needed for successful establishment of seedlings. In general, seedlings should be watered weekly with 1-2 gallons of water, unless sufficient rainfall has occurred.
 - b. Watering shall be done in a manner to achieve infiltration of water and avoid run-off.
 2. Mowing
 - a. Mowing between rows of trees shall be done according to Section 02936 – Seeding.
 3. Herbicide Treatment
 - a. Herbicide treatment of herbaceous and/or woody plants around seedlings shall be done if excessive growth is choking-out trees as determined by Landscape Architect.
 - b. Seedlings shall be protected from contact with herbicide.
 4. Insects, Disease, Fungus
 - a. Should problems with seedlings such as insect infestation, disease or fungus, Contractor shall immediately notify the Landscape Architect and discuss remedies.
 - b. Contractor shall proceed expeditiously with selected treatment of affected areas and continue treatment until the problem is resolved.
 - c. Contractor shall have state licensed applicators for treatment products as needed.

END OF SECTION 32 9230

SECTION 32 9300 – PLANTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes

- 1. Plant Material and Associated Work
 - a. Trees and Shrubs
 - b. Ornamental Grass, Flowers, and Groundcover
 - c. Bioswale Plants
 - d. Erosion Control Blanket
 - e. Associated Materials
 - f. Maintenance
 - g. Warranty
- 2. Related Requirements
 - a. All exterior improvement work

1.3 DEFINITIONS

- A. U.S.D.A. Standards for Nursery Stock, American Association of Nurserymen
- B. Standardized Plant Names, American Joint Committee on Horticulture Nomenclature
- C. National Arborists Association Pruning Standards.

1.4 ACTION SUBMITTALS

A. Prior to commencing work

- 1. Sources and photographs of proposed plant material.
- 2. One-half cubic foot sample each of fine-textured and medium-textured hardwood mulch.
- 3. Product information and cut sheets for erosion control blanket.

B. Upon completion of work

- 1. Tags from fertilizer and soil amendments used in the project.

1.5 QUALITY ASSURANCE

- A. Contractor is responsible to protect and avoid all existing above ground and underground utilities during construction operations. Repair of any utilities damaged by installation is the responsibility of the Contractor.

- B. Contractor is responsible to protect all existing conditions including structures, pavements, and plant material from damage during project installation and maintenance. Any damages occurring are the responsibility of the Contractor to replace, repair or compensate the Owner for damages.
- C. All work described in this Section is to be done by a firm specializing in such work with documented 5 years minimum experience in plant material installation. The personnel of the firm are to be experienced in the work specified and work under the direction of a foreman with 3 years minimum experience.
- D. Contractor personnel engaged in herbicide application to have an Illinois Applicator's License.
- E. Tree trimming to be done by a certified arborist.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver plant material to the site within 48 hours of installation.
- B. Transport and handle plant material to avoid physical damage and desiccation. Use protective covering during shipment.
- C. Keep plants in the shade, roots moist, and protect from weather and mechanical damage.
- D. During installation, handle plants to avoid damage. Should any plant parts be damaged during operations, the Landscape Architect will decide if immediate replacement is required.
- E. Store fertilizer above ground and covered with polyethylene to minimize moisture absorption.

1.7 WARRANTY

- A. Contractor shall warranty all material and work in this project for one complete year, starting after final project acceptance. Any plant replacements prior to project acceptance are not considered warranty replacements. Contractor will provide one replacement of each plant, if necessary, in accordance with these plans and specifications. During this time if a plant dies, becomes diseased or unsightly, the Landscape Architect may request immediate or future replacement and the Contractor shall promptly comply.

PART 2 – PRODUCTS

2.1 PRODUCTS AND MATERIALS

- A. All Plant Material
 - 1. Approved by the Landscape Architect prior to installation.
 - 2. Specimen quality.
 - 3. Species and sizes specified.
 - 4. Growth habit representative of species.
 - 5. Free from diseases, insect pests and injuries.
 - 6. Clearly marked as to source, species and variety.
- B. Balled and Burlapped (B&B) Plants
 - 1. Grown in a nursery with climatic conditions similar those at the project site. B&B plants grown south of the St. Louis latitude will not be accepted.

2. Have a single leader unless otherwise specified.
 3. Have been pruned frequently while growing in the nursery to avoid forked leaders, low or uneven branching, asymmetric growth, crossed limbs and scars from pruning.
 4. Dug only when plants are dormant.
 5. Dug in accordance with best nursery practices.
 6. Have solid earthen balls that encompass the fibrous and feeding roots of the plant in accordance with industry standards for species and caliper size.
- C. Container Grown Plants
1. Grown in pots of specified size with high quality rooting medium within 1 inch of the top of the container.
 2. Well grown-in with roots that fully encompass the rooting medium.
 3. Tops that are full and healthy at the time of planting.
- D. Topsoil
1. Loamy soil from the A horizon soil profile of local prairie-type soils.
 2. Imported to the site if on-site topsoil not available and meet the above criteria.
 3. Organic content between 8 and 10 percent.
 4. Free from roots, sticks, weeds, stones, etc. larger than 1 inch in dimension.
 5. Free of foreign material including construction waste, litter and contaminating products.
 6. At least 90 percent must pass the 2.00 mm sieve.
 7. pH between 6.0 and 8.0.
- E. Fine-Textured Wood Mulch: Composted, shredded hardwood of particles no larger than 2" in any dimension and free of all foreign materials.
- F. Medium-Textured Wood Mulch: Composted, shredded hardwood of particles no larger than 4" in any dimension and free of all foreign materials.
- G. Fertilizer: Slow release granular form and contain 14% nitrogen, 14% phosphoric acid and 14% potash.
- H. Herbicide: Non-specific glyphosate weed killer such as Round-up brand.
- I. Pre-emergent herbicide: Slow-release granular type specifically recommended for use in new planting areas.
- J. Erosion Control Blanket
1. Double net straw blanket composed of 100% straw fiber matrix stitched with degradable thread between biodegradable, natural fiber top and bottom nets, rated for 12-month durability
 2. Product S150BN, 12-foot wide rolls, as manufactured by North American Green, supplied by ASP Enterprises, 275 Northwest Blvd., Fenton, MO, 63026, 800/869- 9600, www.aspent.com
 3. Equal as approved by UIS Facilities
- K. Anchor Pins for Geotextile Fabric and Erosion Control Blanket
1. Steel U-shape pins 6.7" x 2.75" neck x 0.23" dia.
- L. Water is available at the site. Contractor to provide all necessary labor and equipment including hoses and watering apparatus to water according to these specifications.

M. Staking materials

1. Hardwood stake 2" x 2" x 3' feet long
2. Wire, 6 gauge
3. Tree protector, reinforced vinyl hos.

PART 3 – EXECUTION

3.1 PLANTING

A. Time of Operations

1. Plant when the climatic and soil conditions are appropriate as confirmed by Landscape Architect.
2. Install plant material
 - a. No later than December 15 for trees.
 - b. No later than September 30 for herbaceous material and small shrubs.
 - c. When temperature is above freezing, and soil is not frozen.
 - d. When soil moisture is 20% to 30%.

B. Site Preparation

1. Locate utilities and any other underground improvements.
2. Provide safeguards as needed to protect structures, pavement and plant material from possible damage during construction.
3. Flag the location of each tree and the perimeter of shrub and planting beds. Notify Landscape Architect to review flagging and make adjustments as needed before digging operations begin.

C. Planting

1. Trees and Shrubs

a. Preparation

- 1) Remove and dispose of all existing turf or other vegetation over areas to be planted and mulched.
- 2) Remove any debris from topsoil in the area to be planted and mulched. Soil to be firm, stable, and at finish grade (see Section 31 2219 – Finish Grading).

b. Excavations

- 1) Excavate plant pits with near vertical sides and flat bottoms. Scarify side walls to allow soil bonding. No smooth or glazed excavated side or bottom surfaces will be allowed.
- 2) Excavate to the dimensions shown on plans.
- 3) Dispose of extra excavated soil on-site as directed by Landscape Architect.
- 4) Leave no excavations open overnight.
- 5) If beds or pits do not adequately percolate as determined by the Landscape Architect, auger hole below the excavation to a depth

determined necessary and backfill with pea gravel as shown on plans and described in Finish Grading Section 31 2219.

- c. Setting Plants
 - 1) Set plants in excavations at the level at which they were grown or slightly higher if base of pit included fill material.
 - 2) Open and pull burlap of B&B plants back from top of ball and tuck around the sides of the ball.
 - 3) Backfill with topsoil in lifts of 6 inches around root balls and firmly hand tamp.
 - 4) Place fertilizer uniformly in the backfill.
 - a) For each ½" of plant diameter use 10 grams of actual fertilizer nutrients.
 - b) For every gallon of container material use 5 grams of actual fertilizer nutrients.
 - d. Saucers of Soil
 - 1) Form saucers around individual plants and groups of plants as shown on plans.
 - e. Watering
 - 1) Water plants thoroughly within 2 hours of installation.
 - 2) Continue watering and other maintenance as described below.
 - f. Pre-emergent Herbicide
 - 1) Treat soil with pre-emergent herbicide according to product recommendations prior to mulch placement.
 - g. Mulch
 - 1) Trees, shrubs, shrub masses and hedges
 - a) Place medium textured hardwood mulch as shown on plans.
 - b) Hold mulch back 3-4" from tree trunks.
 - h. Plant Support
 - 1) Tree staking is not required at the time of planting.
 - 2) If trees begin leaning for any reason, Contractor shall right and immediately stake those trees according to project drawings.
2. Ornamental Grass, Flower, and Groundcover Beds
- a. Planting Preparation
 - 1) Remove and dispose of all turf or other vegetation over areas to be planted and mulched.
 - 2) Remove any debris from topsoil in the area to be planted and mulched. Soil to be firm, stable and at finish grade (see Section 31 2219 – Finish

- Grading).
- b. Excavations
 - 1) Excavate planting beds with near vertical sides and flat bottoms.
 - 2) Excavate to the dimensions shown on plans.
 - 3) Dispose of extra excavated soil as directed by Owner's Representative.
 - 4) Leave no excavations open overnight.
 - 5) If beds do not adequately percolate as determined by the Landscape Architect, auger hole below the excavation to a depth determined necessary and backfill with pea gravel as shown on plans and described in Finish Grading Section – 31 2219.
 - 6) Place topsoil according to project plans.
 - 7) Till beds to a depth of 6 inches forming particles no greater than 1 inch.
 - 8) Cover beds with a 2 inch depth of peat moss and a 2 inch depth of manure, and till again to a depth of 8 inches to thoroughly mix the materials.
 - c. Setting Plants
 - 1) Set plants in excavations at the same level at which they were grown.
 - d. Watering
 - 1) Thoroughly water plants within 2 hours of installation.
 - 2) Continue watering and other maintenance as described below.
 - e. Pre-emergent Herbicide
 - 1) Treat beds with pre-emergent herbicide according to product recommendations prior to placement of mulch.
 - f. Mulch
 - 1) Mulch with fine textured hardwood mulch as shown on the plans.
3. Bioswale Plants
- a. Planting Preparation
 - 1) Begin preparation no sooner than 4-weeks from anticipated time of planting.
 - 2) Finish grade area according to Section 31 2219 – Finish Grading.
 - 3) If existing vegetation is present in the area to be planted, proceed with the following:
 - a) Treat any existing vegetation with Round-up or other glycosphate herbicide.
 - b) Spray entire bioswale area to be planted including backfilled areas at the manufacturer's recommended concentration and rate.
 - c) Check area in 7-10 days. Re-spray any areas not dying-out. Repeat sequence until all existing plants in the area are dead as confirmed by Landscape Architect.
 - b. Erosion Control Blanket

- 1) Place blanket over prepared surface.
- 2) Trench-in edges.
- 3) Secure with anchor pins.
- 4) Cut openings in blanket to accommodate bioswale plants.

c. Excavations

- 1) Excavate plant pits with near vertical sides and flat bottoms, the size of the plant container.
- 2) Place excavated soil on tarp – do not spread on ground surface.

d. Setting Plants

- 1) Set plants in excavations at the same level at which they were grown.
- 2) Backfill with excavated soil.
- 3) Remove remaining soil from the bioswale. Place where directed by Owner's Representative.

e. Mulching

- 1) Place hardwood mulch over erosion control blanket and around plants to a 2" depth according to project plans.

f. Watering

- 1) Thoroughly water plants within two (2) hours of installation.
- 2) Continue watering and other care during maintenance period.

D. Plant Maintenance

1. Maintain plant material for a minimum 90 days after installation or until final project approval, whichever is longer.

2. Maintenance to include

a. Watering

- 1) Water plants as needed to achieve optimum establishment and growth.
- 2) Recommended watering rates:
 - a) Water to achieve a rate of 10 gallons for each tree every 4 days, 5 gallons for each shrub every 4 days, and 5 gallons per square yard of flower beds every 2 days.
 - b) Rainfall may relieve the Contractor of watering at certain times. Monitor conditions and resume watering when needed.
 - c) Water in a manner to achieve infiltration of water and avoid run-off.
- 3) Provide hoses, portable sprinkling devices and other equipment needed for successful watering.
- 4) Water will be provided by the Owner.

b. Weeding

- 1) Keep mulched areas free of weed growth.
- c. Mulch replenishment (bioswale areas)
- 1) If mulch is displaced due to rainfall events or other means, the contractor is responsible to rake or reposition mulch to original position.
 - 2) Additional mulch installation may be necessary depending on the severity of the mulch displacement.
- d. Replacement
- 1) Immediately replace dead or dying plants. Plants replaced during the establishment period are not warranty replacements.

END OF SECTION 32 9300

SECTION 331000 – WATER UTILITIES**PART 1 – GENERAL**

1.1 SUMMARY

A. Section Includes

1. On-site private facilities and public facilities to be owned by the Owner, including water piping, fittings, chilled water supply and return lines, domestic potable waterline and fire protection system supply waterline, valves, and fire hydrants.

B. Related Sections

1. Section 312316 – Excavation
2. Section 312500 – Erosion & Sedimentation Control (Including SWPPP)

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME)

1. ASME B 16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

B. ASTM International (ASTM)

1. ASTM B88 - Seamless Copper Water Tube
2. ASTM D1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
3. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
4. ASTM D2564 - Poly (Vinyl Chloride) (PVC) Solvent Cement
5. ASTM D2672 - Poly (Vinyl Chloride) (PVC) Integrally Molded Bell Ends for Solvent - Cemented Pipe Joints.
6. ASTM D3139 - Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals
7. ASTM F477 - Elastomeric Gaskets and Lubricant
8. ASTM F656 - Poly (Vinyl Chloride) (PVC) Cement Primer

C. American Water Works Association (AWWA)

1. AWWA C104 – Cement-Mortar Lining for Ductile-Iron Pipe And Fittings For Water
2. AWWA C105 – Polyethylene Encasement for Ductile Iron Piping for Water and other Liquids
3. AWWA C116 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service
4. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

5. AWWA C153 - Ductile-Iron Compact Fittings for Water Service
6. AWWA C500 - Gate Valves for Water and Sewage Systems
7. AWWA C550 - Protective Interior Coatings for Valves and Hydrants
8. AWWA C504 - Rubber-Seated Butterfly Valves
9. AWWA C600 - Installation of Ductile-Iron Water Mains and Appurtenances
10. AWWA C605 - Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
11. AWWA C651 - Disinfecting Water Mains
12. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches through 12 Inches, for Water Distribution

D. National Fire Protection Associations (NFPA)

1. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances

E. Standard Specifications for Water and Sewer Construction in Illinois, latest edition.

1.3 QUALITY ASSURANCE

- A. Products, where marked for compliance with code or test standards, shall also mark specific standard as required in the Contract Documents.
- B. Perform installation in accordance with utility company or municipality requirements.
- C. Valves: Mark manufacturer's name and pressure rating on valve body.
- D. Perform disinfection of potable lines in accordance with AWWA C651.

1.4 SUBMITTALS

- A. Product Data: Provide Project Engineer with data on pipe materials, pipe fittings, hydrants, valves, and accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed state or local requirements.
- C. Furnish 1 copy of results of meter test and hydrostatic pressure test to Owner and utility company upon completion of water distribution backfilling operations.
- D. Project Record Documents:
 1. Disinfection report: Record the following:
 - a. Type and form of disinfectant used.
 - b. Date and time disinfectant injection start and time of completion.
 - c. Test locations.
 - d. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - e. Date and time of flushing start and completion.
 - f. Disinfectant residual after flushing in ppm for each outlet tested.

2. Bacteriological report: Record the following:
 - a. Date issued, project name, testing laboratory name, address, and tele- phone number.
 - b. Time and date of water sample collection.
 - c. Name of person collecting samples.
 - d. Test locations
 - e. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
 - f. Coliform bacteria test results for each outlet tested.
 - g. Certification that water conforms, or fails to conform, to bacterial standards.
 - h. Bacteriologist's signature and authority.
3. Accurately record actual locations of piping mains, valves, connections, and top of pipe elevations.
4. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

PART 2 – PRODUCTS

2.1 PIPE

- A. Domestic potable and fire supply system pipe sizes less than or equal to 3-inches that are installed below grade and outside building shall comply with one or combination of following unless otherwise specified on plans or approved by utility company:
 1. Seamless Copper Tubing: Type "K" soft copper, ASTM B88.
 - a. Fittings: Wrought copper (95-5 Tin Antimony solder joint), ASME B 16.22.
- B. Domestic potable and fire supply system pipe sizes 4 to 16 inches that are installed below grade and outside building shall comply with one or combination of following:
 1. Ductile Iron Water Pipe: AWWA C151, Pressure class 350 (4-12") Pressure Class 250 (14-16").
 - a. Fittings: Either mechanical joint or push-on-joint, AWWA C153, and shall be coated with a 6-8 mil nominal thickness fusion bonded epoxy conforming to the requirements of AWWA C550 and C116, or cement mortar lined in accordance with AWWA C104.
 - b. Elastomeric gaskets and lubricant: ASTM F477.
- C. Pre-insulated direct bury piping for chilled water supply that is installed below grade and outside building shall comply with one or combination of following:

1. Ductile Iron Water Pipe: Class 50 pipe per AWWA C151 with gasketed joints made of styrene butadiene rubber.
 - a. Acceptable Manufacturers:
 - i. Rovanco
 - ii. Perma-Pipe
 - iii. Insul-Pipe Systems
 - iv. Equal as approved by UIS Facilities.
 - b. Insulation: The pipe insulation shall be 2" thick polyurethane foam with 2.0 lbs/sf minimum density, 90% minimum closed cell content and initial thermal conductivity of 0.16 Btu in./Hr. Ft² degrees F. The insulation shall completely fill the annular space between the pipe and jacket and shall be bonded to both.
 - c. Accessories: Elbow, tees, reducers, anchors, field joints, and end seals shall be designed and factory fabricated to prevent the ingress of moisture into the system.
 - d. Insulation Jacket: The outer protective insulation jacket shall be 0.125" thick seamless high-density polyethylene (HDPE) in accordance with ASTM D1248 Type 3, Class C.
 - e. Fittings: Fittings shall be mechanical joint and poured in a thrust block. All pipe fittings shall be furnished by the pre-insulated pipe manufacturer. Fittings shall be AWWA C110 or AWWA C111.
 - f. Field Joints: The service pipe shall be hydrostatically tested to 150 psig or 1 1/2 times the design pressures whichever is greater. Insulation shall then be poured in place into the field joint area. All field-applied insulation shall be placed only in straight sections of pipe. Field insulation of fittings is not acceptable. The installer shall seal the field joint area with a heat shrinkable adhesive backed sleeve. Backfilling shall not begin until the heat shrink sleeve has cooled.
 - g. Backfill: A 4-inch layer of sand or fine gravel shall be placed and tamped in the trench to provide uniform bedding for the pipe. The entire trench width shall be evenly backfilled with a similar material as the bedding in 6 inch compacted layers to a minimum height of 6 inches above the top of the insulated pipe. The remaining trench shall be evenly and continuously backfilled and compacted in uniform layers with suitable excavated soil. Backfill from top of pipe to grade, of compacted fill shall meet H-20 Highway Loading.

2.2 VALVES

- A. Gate Valves, 2-Inches and Larger:
 - 1. Manufacturer and Model: Mueller Resilient Wedge Gate Valves.
 - 2. Equal as approved by UIS Facilities.
 - 3. AWWA C500, Iron body, non-rising stem with square nut, single wedge, resilient seat, flanged or mechanical joint ends, control rod, post indicator where indicated on Construction Drawings, extension box and valve key.
- B. Ball Valves, 2-Inches and Smaller:
 - 1. Manufacturer and Model: Mueller Oriseal.
 - 2. Equal as approved by UIS Facilities.
 - 3. Brass body, teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA compression inlet end, compression outlet with electrical ground connector, with control rod, extension box and valve key.
- C. Check Valves, Post Indicator Valves, and Backflow Preventors
 - 1. Refer to Section 13900 - Fire Suppression in Architectural/Building Specifications

2.3 FIRE HYDRANTS

- A. Fire Hydrants: Type as required by utility company/Local Fire Department/UIS Facilities/NFPA 291
- B. Classification of Hydrants (Per Chapter 5, Annex B, NFPA 291).
 - 1. Class AA – Rated capacity of 1,500 gpm or greater.
 - 2. Class A – Rated capacity of 1,000 – 1,499 gpm
 - 3. Class B – Rated capacity of 500 – 999 gpm.
 - 4. Class C – Rated capacity of less than 500 gpm.
- C. Fire Hydrant Color Designations (Per Chapter 5, Annex B, NFPA 291).
 - 1. Class AA – Light blue
 - 2. Class A – Green
 - 3. Class B – Orange
 - 4. Class C - Red
- D. Hydrant Extensions: Fabricate in multiples of 6-inches with rod and coupling to increase barrel length.
- E. Hose and Steamer Connections: Match sizes with utility company, with two hose nozzles, one pumper nozzle.
- F. Finish: Apply primer and 2 coats of enamel or special coating to color as required by utility company.

2.4 ACCESSORIES

- A. Thrust Blocking: Place 3000 psi concrete to provide sufficient bearing area to transmit unbalanced thrust from bends, tees, caps, or plugs to undisturbed soil without loading un- disturbed soil in excess of 2,500 pounds per square foot when water main pressure is 100 psi.

MINIMUM THRUST BLOCKING BEARING AREAS

Pipe Diameter	Tees Sq. Ft.	90° Bend Sq. Ft.	45° Bend Sq. Ft.	22 1/2° Bend Sq. Ft.	11 1/4° Bend Sq. Ft.	5 5/8° Bend Sq. Ft.	Cap/Plug Sq. Ft.
3"	1.0	1.0	1.0	1.0	1.0	1.0	1.5
4"	1.0	1.0	1.0	1.0	1.0	1.0	2.0
6"	1.5	2.0	1.0	1.0	1.0	1.0	3.0
8"	2.5	3.5	1.8	1.0	1.0	1.0	4.0
10"	4.0	5.5	2.8	1.5	1.0	1.0	6.0
12"	6.0	8.0	4.0	22.0	1.5	1.0	8.5
14"	8.0	11.0	5.5	3.0	2.0	1.5	12.0
16"	10.0	14.2	7.0	4.0	3.0	2.5	15.0
18"	21.0	21.0	12.0	6.0	4.0	3.5	24.0

- B. Locked mechanical joint fittings shall be installed where vertical changes in direction are required and, if approved by Owner and governing authority, can be installed in lieu of above thrust blocking requirements.
- C. Polyethylene Encasement: Single layer of two ply cross-laminated high density polyethylene encasement per AWWA C105, Section 4.1.2, Type III, Class C (Black), Grade 33, tensile strength 5,000 psi minimum, elongation 100 percent, thickness nominal 0.004 inch (4 mil).
- D. Trace Wire: Magnetic detectable conductor, (#12 Copper) brightly colored plastic covering imprinted with "Water Service" in large letters.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and depth are as indicated on Construction Drawings.

3.2 PREPARATION

- A. Ream pipe and tube ends and remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.

- C. Prepare pipe for connections to equipment with flanges or unions.
- D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

3.3 TRENCHING AND BEDDING

- A. Excavate pipe trench and place bedding material in accordance with Section 312323.

3.4 INSTALLATION - PIPE AND FITTINGS

- A. Maintain separation of water main from sanitary and storm sewer piping in accordance with state or local codes.
- B. Install ductile iron pipe and fittings in accordance with AWWA C600.
- C. Install PVC pipe and fittings in accordance with AWWA C605.
- D. Ductile iron pipe and fittings shall be installed with polyethylene encasement around the pipe for the entire length of the project except where water main is within steel casing or is concrete encased. Install polyethylene encasement in accordance with AWWA C105, Method A.
- E. Install pipe to allow for expansion and contraction without stressing pipe or joints or as specified by pipe manufacturer.
- F. Install access fittings in accordance with local codes to permit disinfection of water system performed under this Section.
- G. Connections with Existing Pipelines: Where connections are made between new work and existing piping, make connection using suitable fittings for conditions encountered. Make each connection with existing pipe at time and under conditions with least interference with operation of existing pipeline and in compliance with local utility company.
- H. Form and place concrete for thrust blocks or other specified methods of retainage at each change of direction or end of pipe main.
- I. Place pipe to depth in accordance with Section 312316.
- J. Backfill trench in accordance with Section 312323.
- K. Install trace wire continuous over top of non-metal pipe. Bury a minimum of 6 inches below finish grade, and above pipeline.

3.5 INSTALLATION - VALVES AND HYDRANTS

- A. Install gate valves as indicated on Construction Drawings. Support valve on concrete pads with valve stem vertical and plumb. Install valve boxes in manner that will not transmit loads, stress, or shock to valve body. Center valve box over operating nut of valve vertical and plumb. Securely

fit valve box together leaving cover flush with finished surface.

- B. Install fire hydrant assemblies as indicated on Construction Drawings in vertical and plumb position with steamer/pumper nozzle pointed perpendicular to traffic where hydrant is adjacent to street, roadway, or parking lot drive or toward protected building unless otherwise directed by local authorities. Support hydrant assembly on concrete pad and firmly brace on side opposite inlet pipe against undisturbed soil and concrete blocking. Place minimum of 6-cubic feet of crushed stone or gravel around hydrant base and barrel after thrust blocking has cured at least 24 hours. Maintain vertical position of hydrant backfilling and compacting.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect distribution system with chlorine before acceptance for domestic operation. Chlorine dosage shall be not less than 50 parts per million. Flush lines before introduction of chlorinating materials and after contact period of not less than 24 hours. Flush with clean water after contact period until residual chlorine content is not greater than 1.0 part per million. Flush water discharged from water supply lines or hydrants shall not be allowed to discharge directly onto exposed soil or turf which could result in erosion of soil. If potential for erosion exists at discharge point, measures shall be taken to prevent erosion. Open and close valves in lines being disinfected several times during contact period. After disinfection, take water sample and bacteriological test in accordance with AWWA C651. Satisfactory disinfection shall be demonstrated in accordance with the requirements of Title 35 of the Illinois Administrative Code 652.203. Do not place distribution system in service until approval is obtained from local governing authorities.
- B. Contractor shall provide a means of neutralizing the super-chlorinated water before re-leasing into the environment. This may be accomplished by either a method of dechlorination, direct release into a detention area approved by Wal-Mart, or any method acceptable to federal, state, and local codes. Direct release to open ground shall not be allowed, unless contained within an on site detention facility with 6" permanent storage. In this case, the Contractor shall time the release to assure that no rainstorms are imminent. The intent of this condition is to allow the majority of the chlorine to evaporate into the atmosphere before a rainstorm has the opportunity to wash the residual downstream. Contractor shall not release super-chlorinated water directly into the sanitary sewer system, private or public, nor any storm drain system not directly discharging into the detention facility.

3.7 SERVICE CONNECTIONS

- A. Provide water service connection in compliance with utility company requirements including reduced pressure backflow preventor (if required) and water meter with by-pass valves and sand strainer.

3.8 FIELD QUALITY CONTROL

- A. Test water distribution system pipe installed below grade and outside building in accordance with the following procedures:

1. Perform testing of pipe materials, joints, and other materials incorporated into construction of water mains and force mains to determine leakage and water tightness. Test pressure pipeline in accordance with Section 4 of AWWA C600 and NFPA 24. In the event state or local code requires more stringent test, more stringent test shall take precedence.
2. Pressure Test: After pipe has been laid, subject newly laid pipe or valved section to hydrostatic pressure of at least 1.5 times working pressure at point of testing and not less than 1.25 times working pressure at highest point along test section.
3. Leakage Test: Conduct leakage test concurrently with pressure test. Leakage is defined as quantity of water that must be supplied into newly laid pipeline or valved section thereof to maintain pressure within 5 psi of specified test pressure after air in pipeline has been expelled and pipeline has been filled with water. Leakage shall not be measured by drop in pressure in test section over period of time.
 - a. Leakage test for ductile iron pipe shall not be greater than that determined by the following formula:

$$L = \frac{SD(P)^{1/2}}{133,200}$$

Where: L = allowable leakage,
 (gallons per hour) S =
 length of pipe tested,
 (feet)
 D = nominal diameter of pipe, (inches)
 P = average test pressure during test, (psig)
 - b. Leakage test for PVC pipe shall be in accordance with AWWA Standard C605.
4. Visible Leakage: Repair visible leaks regardless of amount of leakage measured.
5. Acceptance of Installation: If test of pipe laid in place discloses leakage greater than that specified, Contractor shall, at his own expense, locate leak and make repairs as necessary until leakage is within specified allowance. Supply water for testing at no expense to Owner.

END OF SECTION 331000

SECTION 333100 – SANITARY SEWAGE UTILITIES**PART 1 – GENERAL**

1.1 SUMMARY

- A. Section Includes
 - 1. Site sanitary sewer drainage piping, fittings, accessories, cleanouts, and bedding.
 - 2. Connection of site sanitary sewer system to municipal sanitary sewer systems.
- B. Related Sections
 - 1. Section 312316 – Excavation
 - 2. Section 312323 – Fill
 - 3. Section 312500 – Erosion & Sedimentation Control (SWPPP)
 - 4. Section 333900 – Sanitary Utility Sewerage Structures

1.2 REFERENCES

- A. ASTM International (ASTM)
 - 1. ASTM A74 - Cast Iron Soil Pipe and Fittings
 - 2. ASTM A746 - Ductile Iron Gravity Sewer Pipe
 - 3. ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings
 - 4. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings
 - 5. ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
 - 6. ASTM D2241 - Poly (vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
 - 7. ASTM D2657 - Heat-Joining Polyolefin pipe and Fittings
 - 8. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
 - 9. ASTM D3035 - Polyethylene (PE) Plastic Pipe Using Flexible Elastomeric Seals
 - 10. ASTM D3139 - Joints for Plastic Pressure Pipe Using Flexible Elastomeric Seals
 - 11. ASTM D3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
 - 12. ASTM D3261 - Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Poly- ethylene Plastic Pipe and Tubing
 - 13. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe
 - 14. ASTM F1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.

- B. American Water Works Association (AWWA)
 - 1. AWWA C111 - Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
 - 2. AWWA C600 - Ductile-Iron Water Mains and Their Appurtenances
 - 3. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In, For Water Distribution
 - 4. AWWA C901 - Polyethylene (PE) Pressure Pipe, Tubing and Fittings 1/2 Inch through 3 Inches, For Water Distribution
 - 5. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 Inch through 63 Inch, for Water Distribution
- C. Standard Specifications for Water and Sewer Construction in Illinois
- D. Illinois Department of Transportation (IDOT), Standard Specifications for Road and Bridge Construction, latest edition

1.3 SUBMITTALS

- A. Product Data: Provide data of pipe materials, pipe fittings, and accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified or local requirements.
- C. Project Record Documents:
 - 1. Accurately record actual locations of pipe runs, connections, cleanouts, and in-vert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.4 PROJECT CONDITIONS

- A. Coordinate work with termination of sanitary sewer connection outside building and connection to municipal sewer utility service.

PART 2 – PRODUCTS

2.1 SEWER PIPE, FITTINGS, AND JOINTS

- A. Polyvinyl Chloride Pipe (PVC): ASTM D 3034, rated SDR 35 or 26 as shown on plans or unless otherwise specified by the utility company. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification.
 - 1. Pipe joints: Integrally molded bell ends, ASTM D 3212, with factory supplied elastomeric gaskets and lubricant meeting ASTM F477.

- B. Force Main:
1. High-Density Polyethylene Pipe (HDPE): AWWA C901 and C906, ASTM D3035, SDR 11 for 150 psi pressure rating.
 - a. Fittings: Molded, AWWA C901 or C906.
 - b. Joints: Butt fusion, ASTM D2657, flanged gasket joints at interface
 2. Polyvinyl Chloride Pipe (PVC): For less than 4 inches in diameter, ASTM D2241 for push-on or solvent weld joints, and for pipe 4 inches in diameter and larger, AWWA C900, Class 150 with push-on joints.
 - a. Joints/Fittings: Push-on, ASTM D3139 with ASTM F477 gaskets.
 - b. Solvent Cement: ASTM D2564.
 3. Ductile Iron Pipe (DIP): ASTM A746, Class 50, inside nominal diameter as shown on the drawings, bell and spigot end.
 - a. Ductile Iron Pipe Joint Device: AWWA C111, rubber gasket joint devices.

2.2 PIPE ACCESSORIES

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene-ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in re- quired tee, bends, elbows, cleanouts, reducers, traps, etc.

2.3 CLEANOUTS

- A. Lids and Frames shall conform to Section 32 of the Standard Specifications for Water and Sewer Construction in Illinois and the details in the plans. Provide traffic grade and rated covers and frames where cleanouts are within pavement, with the letters "SSCO" cast into the cover.
- B. Shaft Construction: Cast iron shaft of internal diameter as specified on Construction Drawings with 2500 psi concrete collar for cleanouts.

2.4 APPURTENANCES

- A. Trace Wire: Magnetic detectable conductor (#12 copper), brightly colored plastic covering, imprinted with "Sanitary Sewer Service" in large letters.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that trench cut and excavation is ready to receive work and

excavations, dimensions, and elevations are as indicated on Construction Drawings.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
- B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

3.3 BEDDING

- A. Excavate trench and place bedding material in accordance with Division 32.

3.4 INSTALLATION - PIPE

- A. Install type and class of pipe as shown on the drawings. Pipes shall be laid and maintained to the required line and grade with necessary fittings, bends, manhole risers, cleanouts and other appurtenances placed at the required locations. The pipe shall be installed with uniform bearing under the full length of the barrel of the pipe. The pipe shall be inspected for defects and cracks before being lowered into the trench. Defective, damaged or unsound pipe, or pipe that has had its grade disturbed after laying shall be taken up and replaced. Commence installation at lowest point with the bell end upgrade.
- B. No pipe shall be laid in water or when trench conditions are unsuitable for work.
- C. Pipe connecting to manholes or other structures shall terminate flush inside of the structure wall.
- D. Joints for PVC and CISP shall be thoroughly lubricated with an approved lubricant before pipe sections are slipped together. Open ends shall be fully protected with a stopper to prevent earth or other material from entering the pipe during construction. Carefully free interior of the pipe from dirt, cement and other deleterious material as the work progresses.
- E. Maintain separation of potable water main from sewer piping at crossings a minimum of 10 feet horizontal and 18 inches vertical.
- F. Install HDPE piping and fittings to AWWA C901 and C906. Butt fusion welded per ASTM D3261.
- G. Route pipe in straight line parallel to roads, buildings and adjacent utilities and as shown on the drawings.
- H. Establish elevations of buried piping with sufficient cover as recommended by pipe manufacturer to ensure not less than 3 feet of cover, except as noted on drawings.

- I. Form and place concrete for thrust blocks at each elbow of pipe force main. See construction drawing for details of construction.
- J. Backfill trench in accordance with Section 312323.
- K. Install trace wire continuous over top of non-metal pipe. Bury 6 inches minimum below finish grade, above pipeline.

3.5 FIELD QUALITY CONTROL

- A. Pipes and joints shall not be completely backfilled until after inspection, testing, and approval by the Owner and local jurisdiction.
- B. Prior to testing for leakage, the pipe trench shall be backfilled to at least the spring line of the pipe. If required to prevent pipe movement during testing, additional backfill shall be added leaving the pipe joints uncovered to permit inspection.
- C. Exfiltration Test
 - 1. Each section of sewer line between successive manholes shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper man- hole, using stoppers.
 - 2. Fill the manhole and pipe with a minimum 24 inches of water above the crown of the sewer at the center of the upper manhole; or if groundwater is present, 24 inches of head above the average adjacent groundwater level.
 - 3. The allowable leakage shall be 240 gal/inch of pipe diameter/mile/day.
 - 4. Testing shall be in accordance with the Standard Specifications for Water and Sewer Main Construction in Illinois, Section 31-1.13.
- D. Infiltration Test
 - 1. If excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test shall not be used.
 - 2. The upper and lower ends of the sewer to be tested shall be closed sufficiently to prevent the entrance of water.
 - 3. Pumping of ground water shall be discontinued for at least 3 days; then infiltration shall be tested.
 - 4. Infiltration into each section of sewer between adjoining manholes shall not exceed that allowed for the exfiltration test, except that head conditions shall be a maximum of 6 feet.
 - 5. The allowable leakage shall be 200 gal/inch of diameter/mile/day.

6. Testing shall be in accordance with the Standard Specifications for Water and Sewer Main Construction in Illinois, Section 31-1.13.
- E. The Exfiltration Test may be limited to the manholes only when the authority having jurisdiction does not require the test and the construction manager waives the test. The In-filtration Test will always be required when excessive ground water is encountered in addition to the air test.
- F. Air Test: Gravity systems shall be air tested between manholes at 3.5 psi for 5 minutes per ASTM F1417 for plastic pipes.
- G. Deflection Test:
 1. Deflection tests shall be conducted on all plastic pipe using a mandrel with a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.
 2. Allowable Deflection: Maximum allowable pipe deflection shall not exceed 5 percent of nominal inside diameter.
 3. Mandrel: Mandrel, go/no-go, device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. Contact length of mandrel's arms shall equal or exceed nominal inside diameter of sewer to be inspected. Critical mandrel dimensions shall carry tolerance of 0.01-inch maximum. Contractor shall provide mandrel and necessary equipment for mandrel test.
 4. Procedure: Mandrel shall be hand-pulled through flexible pipe sewer lines no earlier than 30 days after trench has been completely backfilled. Sections of sewer not passing mandrel shall be uncovered and rebedded, rerounded, or replaced to satisfaction of Owner or governing agency. Repaired section shall be retested.
- H. Hydrostatic Test: Force main piping shall be hydrostatically tested at 150 psi in accordance with AWWA C 600.
- I. Provide measuring devices, meters, water, materials, and labor for making the required tests.
- J. Tests shall be conducted in the presence of the Engineer. Test data shall be submitted to the Engineer for review and approval.

END OF SECTION 333100

SECTION 333900 – SANITARY UTILITY SEWERAGE STRUCTURES**PART 1 – GENERAL**

1.1 DESCRIPTION OF THE WORK

- A. Contractor shall provide:
 - 1. Modular precast concrete manhole sections with tongue-and-groove joints, covers, anchorage and accessories for manholes as indicated on the drawings.
 - 2. All labor, equipment and materials required for a complete installation.

1.2 RELATED WORK

- A. Section 312316 – Excavation
- B. Section 312323 – Fill
- C. Section 333100 – Sanitary Sewage Utilities

1.3 REFERENCES

- A. ASTM International (ASTM)
 - 1. ASTM A48 - Gray Iron Castings.
 - 2. ASTM C478 - Precast Reinforced Concrete Manhole Sections.
 - 3. ASTM C923 - Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes.
- B. Standard Specifications for Water and Sewer Construction in Illinois, latest edition.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate manholes locations, elevations, sizes and elevations of penetrations.
- B. Product Data: Provide manhole covers, component construction, features, configuration and dimensions.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section approved by IDOT for this type of work.

PART 2 – PRODUCTS

2.1 MATERIALS - MANHOLES

- A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478.

- B. Joints: joints between precast sections shall be sealed with preformed flexible gaskets, rubber gaskets, or butyl rope to ensure a watertight joint. Flexible gaskets shall conform to the requirements of ASTM C990. Rubber gaskets shall conform to the requirements of ASTM C443
- C. Pipe Connections: for sanitary sewer or process piping shall be A-LOK Premium gaskets by A-LOK Products, Inc. Connections for storm sewers shall be non-shrink grout on each side of the manhole wall.
- D. Adjustment Rings: concrete adjustment rings shall have a minimum thickness of two (2) inches. No more than two (2) adjustment rings for a total height of eight (8) inches shall be allowed.

2.2 COMPONENTS - MANHOLES

- A. Lid and Frame: ASTM A48, Class 35B cast iron construction, machined flat bearing surface, removable lid, closed lid design. Frame and lid shall be Neenah, R-1713, Type B lid unless noted otherwise and the construction plans. Provide traffic grade and rated covers and frames where cleanouts and manholes are within pavement, with the letters "SSCO" or "SANITARY SEWER" respectively cast into the cover.
- B. Manhole Steps: 3/4 inch diameter formed integral with manhole sections. Steps shall be copolymer polypropylene encapsulating a 1/2" steel reinforcing rod, as manufactured by M.A. Industries.

2.3 CONFIGURATION - MANHOLES

- A. Shaft Construction: Concentric with eccentric cone (corbel) top section.
- B. Shape: Cylindrical
- C. Clear Inside Dimensions: As indicated on the drawings.
- D. Design Depth: As indicated.
- E. Clear Lid Opening: 24 inches.
- F. Pipe Entry: Provide openings as indicated.
- G. Steps: 12 inches wide, 16 inches on center vertically, set into manhole wall.
- H. Bottom shall be integral with lowest barrel section.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify items provided by other sections of work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into work.

- C. Verify excavation for manholes is correct.

3.2 PREPARATION

- A. Coordinate placement of inlet and outlet pipes.
- B. Form bottom of excavation clean and smooth to correct elevation.

3.3 PLACING MANHOLE SECTIONS

- A. Place base pad.
- B. Place manhole sections plumb and level.
- C. Where manholes are to be connected to existing sewers or constructed over existing sewers, the Contractor shall submit a method of procedure to the Engineer detailing the method of construction and how the existing sewer lines shall be kept in service while manhole installation is conducted.
- D. Construct inverts according to the following guidelines:
 - 1. Invert channel shall be smooth and accurately shaped to a semicircular bottom to match with the inside of the adjacent sewer section.
 - 2. Invert channels and structure bottoms shall be shaped with mortar and lean concrete.
 - 3. Changes in size and grade of invert shall be made gradually and evenly.
 - 4. Changes in the direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.
- E. Provide manhole rings, frame, and cover as shown on the construction drawings.

3.4 SCHEDULES

- A. Manholes: Precast concrete sections, steps, inside diameter as indicated on the drawings to depth indicated, with closed lid.

3.5 Testing

- A. Manholes should be tested in accordance with the Standard Specifications for Water and Sewer Construction in Illinois, latest edition.

END OF SECTION 333900

SECTION 334000 – STORM DRAINAGE UTILITIES**PART 1 – GENERAL**

1.1 WORK INCLUDES

- A. Storm sewer system including pipes and bedding material indicated on drawings.
- B. Fittings and accessories to complete the drainage system.

1.2 RELATED WORK

- A. Specified elsewhere:
 - 1. Section 312316 – Excavation
 - 2. Section 312323 – Fill
 - 3. Section 312500 – Erosion & Sedimentation Control (with SWPPP)
 - 4. Section 334900 – Storm Drainage Structures

1.3 REFERENCES. Specified references, or cited portions thereof, current at date of bidding documents unless otherwise noted, govern the work.

- A. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, including all addenda, latest edition.
- B. Standard Specifications for Water & Sewer Main Construction in Illinois, latest edition.

1.4 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Section 550 of the Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, including all Supplemental Specifications and Recurring Special Provisions.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Transport, deliver, unload, store and handle all pipe and fittings to prevent damage to materials or work.
- B. All damaged, broken or otherwise defective materials will be rejected.
- C. Store all circular gaskets and special lubricants in packaged materials with manufacturer's name, brand and all other specific data plainly marked thereon.

1.6 SUBMITTALS

- A. Accurately record actual locations of pipe runs, connections, manholes, inlets and invert elevations.

PART 2 – PRODUCTS

2.1 STORM SEWERS

- A. Reinforced Concrete Pipe (RCP) conforming to Article 550.02 and 550.03 of the IDOT Standard Specifications for the size, class and type of sewer shown in the plans.

2.2 JOINT MATERIAL

- A. Concrete Pipe:
 - 1. Mastic Joint Sealer – Conforming to Section 1055 of the IDOT Standard Specifications.
 - 2. Preformed Flexible Gaskets – Conforming to Section 1055 of the IDOT Standard Specifications.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Site Inspection: Inspect site and verify all grades, levels and conditions are as indicated on the layout drawings.
- B. Inspect all areas and conditions where drainage structures are to be installed.
 - 1. Inspect field conditions before ordering materials.
 - 2. Notify Owner or Owner's Representative in writing of conditions detrimental to proper and timely completion of work.
 - 3. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 COORDINATION

- A. Schedule work and notify all crafts in time so provisions for their work can be made without delaying project progress.
- B. All installations conform to lines and grades shown on drawings.
 - 1. Place structures where indicated on drawings unless their location is changed by the Owner or Owner's Representative
 - 2. Field conditions dictate deviation from drawings, no change made without written authorization of the Owner or Owner's Representative.

3.3 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.
- B. Remove large stones or other hard matter that could damage piping or impede consistent backfilling or compaction.

3.4 BEDDING

- A. Excavate pipe trench in accordance with Section 550.04 of IDOT's Standard Specifications for work of this section.
- B. Place bedding material at trench bottom, level materials in a continuous layer.

3.5 INSTALLATION OF STORM SEWERAGE SYSTEM

- A. Storm Sewer Lines: Install pipe, fittings and accessories in accordance with Section 550 of IDOT's Standard Specifications.

3.6 HORIZONTAL SEPARATION – WATER MAINS AND SEWERS

- A. Water mains shall be located at least ten feet horizontally from any existing or proposed drain, storm sewer, sanitary sewer, combined sewer or sewer service connection.
- B. Water mains may be located closer than ten feet to a sewer line when:
 - 1. Local conditions prevent a lateral separation of ten feet; and
 - 2. The water main invert is at least 18 inches above the crown of the sewer; and
 - 3. The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located to one side of the sewer.
- C. When it is impossible to meet (1) or (2) above, both the water main and drain or sewer shall be constructed of slip-on mechanical joint cast or ductile iron pipe, asbestos-cement pressure pipe, prestressed concrete pipe, or PVC pipe equivalent to water main standards of construction. The drain or sewer shall be pressure tested to the maximum expected surcharge head before backfilling.

3.7 VERTICAL SEPARATION – WATER MAINS AND SEWERS

- A. A water main shall be separated from a sewer so that its invert is a minimum of 18 inches above the crown of the drain or sewer whenever water mains cross storm sewers, sanitary sewers or sewer service connections. The vertical separation shall be maintained for that portion of the water main located within ten feet horizontally of any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain.
- B. Both the water main and sewer shall be constructed of slip-on mechanical joint cast or ductile iron pipe, asbestos-cement pressure pipe, prestressed concrete pipe, or PVC pipe equivalent to water main standards of construction when:
 - 1. It is impossible to obtain the proper vertical separation as described in (1) above; or

2. The water main passes under a sewer or drain.
 - C. A vertical separation of 18 inches between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and breaking the water main, as shown on the plans or as approved by the Construction Manager.
 - D. Construction shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer or drain line is at least ten feet.

END SECTION 334000

SECTION 334900 – STORM DRAINAGE**PART 1 – GENERAL**

1.1 WORK INCLUDES

- A. New precast storm sewer inlets and manholes with concrete tops and metal frames, lids or grates and accessories.
- B. Connection of new storm sewer pipe to existing inlet or manhole structure.
- C. Adjust existing manholes, inlets, valve boxes and meter vaults as required by the utility company or the Engineer.
- D. New precast concrete flared end sections and headwalls.

1.2 RELATED WORK

- A. Specified elsewhere:
 - 1. Section 31 23 16 – Excavation
 - 2. Section 33 40 00 – Storm Drainage Utilities

1.3 REFERENCES. Specified references, or cited portions thereof, current at date of bidding documents unless otherwise noted, govern the work.

- A. Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, latest edition, including all addenda.
- B. Standard Specifications for Water & Sewer Main Construction in Illinois, latest edition.
- C. Applicable IDOT Highway Standards – Attached at end of this Section.

1.4 REGULATORY REQUIREMENTS

- A. Conform to the applicable portions of Section 602, 604 and 1024 of the Illinois Department of Transportation (IDOT): Standard Specifications for Road and Bridge Construction, including all Supplemental Specifications and Recurring Special Provisions.

PART 1 – GENERAL

2.1 PRECAST MANHOLE AND INLET SECTIONS, STEPS, FRAMES AND LIDS

- A. The Contractor shall be required to submit shop drawings of each structure for approval in accordance with these documents, prior to fabricating or delivering any manholes.

- B. Manhole and inlet sections, castings and accessories shall conform to Section 602.02 and 604.02 of IDOT's Standard Specifications, IDOT's Highway standards and the project details and drawings included with the contract documents.
- C. Connections for storm sewer pipes shall be grouted in place with non-shrink grout material conforming to Section 1024 of IDOT's Standard Specifications.
- D. Joints between precast manhole sections and under the casting frame shall be watertight and sealed by means of preformed butyl resin rope or by O-ring rubber gasket. Seal material shall not shrink, harden or oxidize with age. Installation shall be according to manufacturer's recommendations and as shown on the drawings.
- E. The Contractor shall adjust the manhole or inlet casting to the final ground line as shown on the plans or as directed by the Engineer in the field. Concrete "adjustment rings" having the same inside diameter as the casting may be used to raise the casting up to a maximum of 6".

PART 3 – EXECUTION

3.1 COORDINATION

- A. Schedule work and notify all crafts in time so that provisions for their work can be made without delaying the project.

3.2 INSTALLATION

A. Excavation

In order to permit the joints to be mortared properly and also to permit proper compaction of the backfill material, the excavation shall be made to a diameter of at least two feet greater than the outside diameter of the structure.

B. Subbase Preparation

Adequate foundation for manhole structures shall be obtained by removal and replacement of unsuitable material with well-graded granular material, by tightening with coarse ballast rock, or by such other means provided for foundation preparation of the connected sewers.

C. Manhole Base Installation (Precast Base)

A well-graded granular bedding course conforming to the requirements for aggregate for trench backfill (Section 312323), not less than four inches in thickness and extending to the limits of the excavation, shall be firmly tamped and made smooth and level to assure uniform contact and support of the precast element. A precise base section shall be carefully placed on the prepared bedding so as to be fully and uniformly supported in true alignment and making sure that all entering pipes can be inserted on proper grade.

D. Precast Manholes

1. Precast manholes may be constructed with a precast base section or a monolithic base structure as specified. Precast sections shall be placed and aligned to provide vertical sides and vertical alignment of the ladder runs. The completed manhole shall be rigid, true to dimensions and shall be watertight.
2. All lift holes in precast elements shall be completely filled with an approved bitumastic material. All joints between precast elements on sanitary sewer manholes shall be made with an o-ring rubber or neoprene gasket.

E. Construction Detail

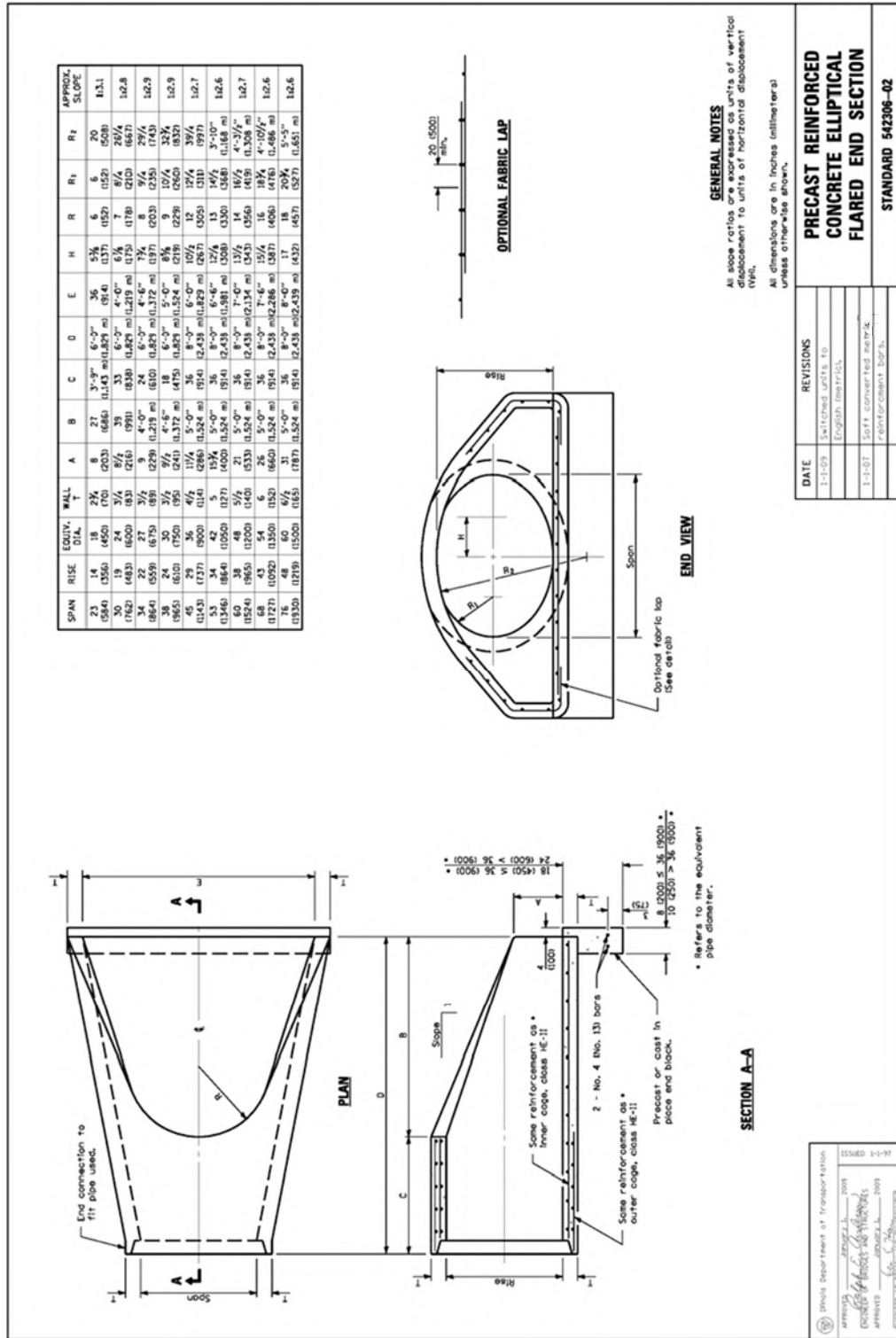
1. Inlet and Outlet Pipes. Pipe or tile placed in the masonry for inlet or outlet connections shall extend through the wall and beyond the outside surface of the wall a sufficient distance to allow for connections, and the masonry shall be carefully constructed around them so as to prevent leakage along the outer surfaces. Special care shall be taken to see that the openings through which pipes enter the structure are completely sealed by use of a nonshrink grout.
2. Placing Castings. Casting adjustments of less than two inches shall be with mortar. The mortar shall be mixed in proportion of one part cement to three parts sand, by volume, based on dry materials. Castings shall be set accurately to the finished elevation so that no subsequent adjustment will be necessary. Castings shall be sealed to concrete sections with bitumastic material.
3. Manhole Inverts. Construct manhole flow channels of concrete or sewer pipe, which shall be of semicircular section conforming to the inside diameter changes in size and grade gradually, and changes in direction shall be by true curves. Provide channels for all connecting sewers to each manhole and benching shown on the drawings.

F. Backfill

The space between the sides of the excavation and the outer surfaces of the manhole shall be backfilled with aggregate for trench backfill when the manhole is in a pavement or when the nearest point of the excavation for the manhole falls within two feet of the paved edge.

G. Cleaning

All newly constructed inlets and manholes and any existing structures modified shall be cleaned of all accumulation of silt, debris or foreign matter of any kind and shall be free of such accumulations at the time of final inspection.



Illinois Department of Transportation
 APPROVED: [Signature] 2009
 PREPARED BY: [Signature]
 APPROVED: [Signature] 2009
 ILLUSTRATION NO. 542306-02

DATE	REVISIONS
1-1-09	SWITCHED UNITS TO English Metric.
1-1-07	Soft converted metric reinforcement details.

PRECAST REINFORCED CONCRETE ELLIPTICAL FLARED END SECTION
 STANDARD 542306-02

GENERAL NOTES
 All slope ratios are expressed as units of vertical displacement to units of horizontal displacement (V:H).
 All dimensions are in inches (millimeter) unless otherwise shown.

SECTION A-A

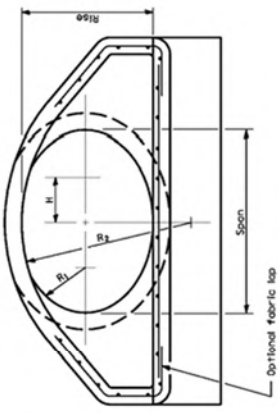
* Refers to the equivalent pipe diameter.

2 - No. 4 No. 13 bars
 Precast or cast in place and block.

Some reinforcement as outer cage, class HE-II

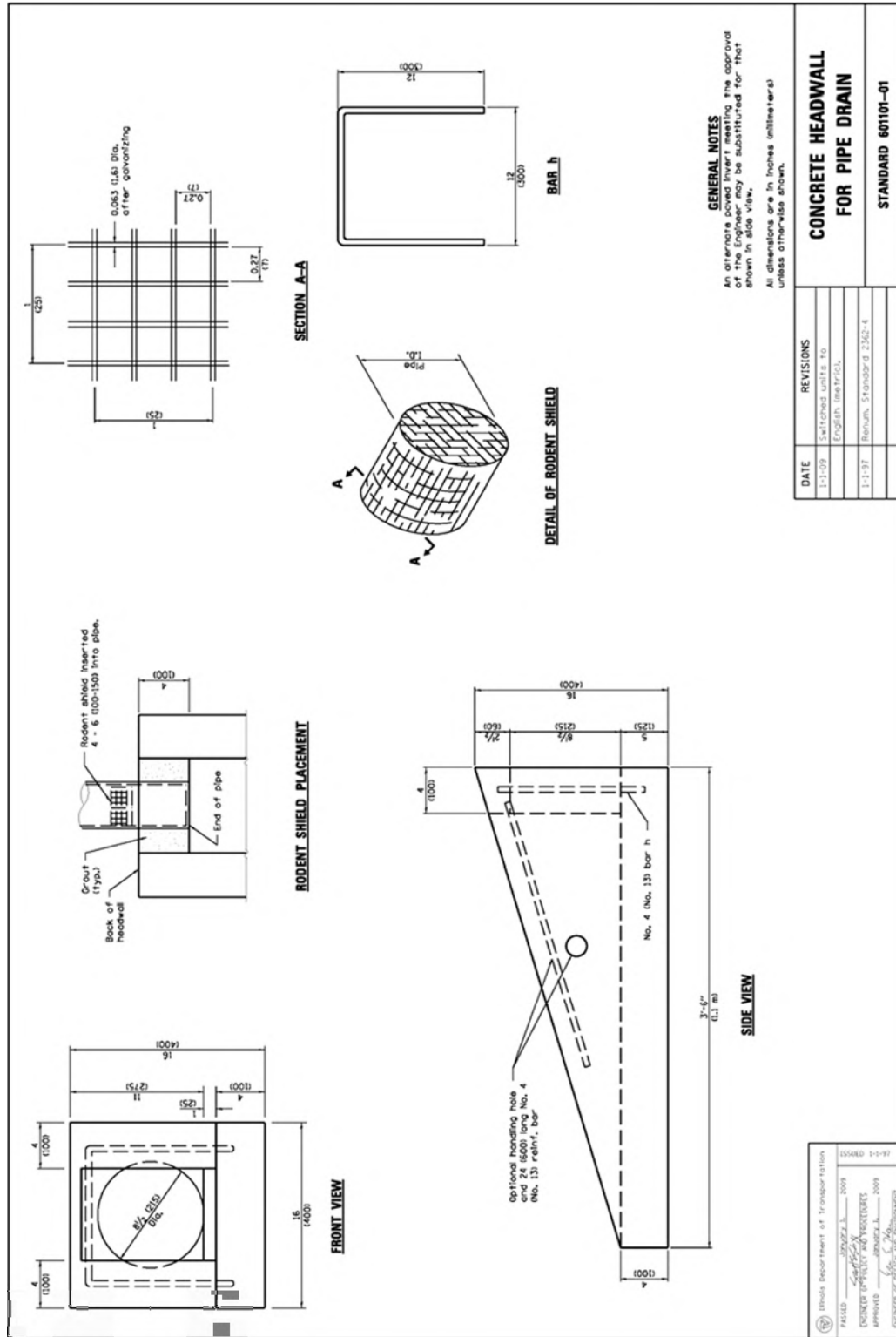
Some reinforcement as inner cage, class HE-II

24 (600) S 36 (900) +
 18 (450) S 36 (900) +
 16 (400) S 36 (900) +



END VIEW

OPTIONAL FABRIC LAP



END OF SECTION 334900

SECTION 335100 – NATURAL GAS DISTRIBUTION**PART 1 – GENERAL**

1.1 SUMMARY

- A. Section Includes
 - 1. This section includes requirements to furnish and install pipe materials, fittings, and valves for natural gas systems to the proposed building or natural gas fired equipment.

1.2 REFERENCES

- A. ASME - Boiler and Pressure Vessel Code.
- B. NFPA 54 - National Fuel Gas Code.
- C. NFPA 58 – Liquefied Petroleum Gas Code.
- D. International Mechanical Code
- E. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless, for ordinary uses.
- F. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- G. ANSI B31.2 - Fuel Gas Piping.

1.3 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. To the greatest extent possible obtain materials from only one manufacturer, even though several may be specified as acceptable manufacturers.
- B. Supplier:
 - 1. Subcontract furnishing of the materials only to a recognized material supplier who has been furnishing materials in the same area as project for a period of not less than 2 years.
- C. Installer:
 - 1. Subcontract installation of materials to a company specializing in the installation in performing work of this section with a minimum 5 years experience. Assign work to experienced tradesmen in compliance with trade union jurisdictions.

D. Installation:

1. Perform work in accordance with State local building codes.
2. Perform work in accordance with industry standards

1.4 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalog information.

1.5 REGULATORY REQUIREMENTS

- A. Perform work in accordance with State and local building codes.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept material on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 – PRODUCTS

2.1 GAS PIPING SYSTEM

- A. Above grade piping, Contractor shall use the following:

1. Steel Pipe: ASTM A53 or A120, Schedule 40 Black.
 - a. Fittings: ASME B 16.3, malleable iron, or ASTM A234, forged steel welding type.
 - b. Joints: NFPA 54, Threaded or welded to ANSI B31.1

- B. Below grade piping, Contractor shall use the following:

1. Plastic Pipe:
 - a. ASTM 2513 pipe specially manufactured for underground gas piping.
 - b. Fittings: Fittings shall be approved for fuel-gas piping systems and compatible with the pipe or tubing.

2.2 GAS COCKS

- A. Lubricated plug cock.
 - 1. Acceptable Manufacturers:
 - a. Homestead Number 601
 - b. Powell Number 2202
 - c. Walworth Number 1700
 - d. Equal as approved by UIS Facilities
 - 2. Full port, semi-steel body, N.P.T. screwed ends.
 - 3. Pressure rating: 200 pounds per square inch WOG.
 - 4. Lubricant:
 - a. Compatible with natural and liquefied petroleum gas.
 - b. Provide 2 spare sticks per valve.

2.3 GAS REGULATORS

- A. Acceptable Manufacturers:
 - 1. American Meter 3000
 - 2. Fisher S200
 - 3. Rockwell 121
 - 4. Equal as approved by UIS Facilities
- B. All gas regulators shall be a standard direct operated regulator. Outlet pressure control type with high tensile iron, screwed ends, high and low pressure shutoff, and synthetic diaphragms. Internal relief valve shall be set at 3 pounds per square inch. Capacity, and inlet and outlet pressures shall be as noted on the drawings. Unit shall be sized such that the design outlet pressure is mid-range of the spring.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify excavations under provisions of Division 31.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

- A. Install in accordance with the manufacturer's instructions, all state and local codes and as described herein and shown on the Drawings.

- Coordinate installation with gas supplier.
- B. Install non-conducting dielectric connections wherever jointing dissimilar metals.
 - C. Route piping in orderly manner and maintain gradient.
 - D. Group piping whenever practical at common elevations.
 - E. Install piping to allow for expansion and contraction without stressing pipes, joints, or connected equipment.
 - F. Provide access where valves and fittings are not exposed.
 - G. Install valves with stems upright or horizontal, not inverted.
 - H. Shut-Off Valves: Installed to isolate sections of the pipe and fixtures for repairs and maintenance, and in the risers and main branches at points of take-off from their main supplies, even when not indicated on the drawings.
 - I. Install unions downstream of valves (if valves do not have unions) and at equipment or apparatus connections.
 - J. Installation of gas piping or appliance shall be performed only by qualified installing agency as defined by the National Fuel Gas Code, NFPA Number 54. All procedures, methods and, materials shall comply with specified portions of NFPA 54.
 - K. While installing gas piping, take all precautions to prevent damage to property and injury to persons. Comply with all regulations and specified codes and the gas utility company.
 - L. Pitch all horizontal gas piping downward in the direction indicated on the drawings not less than 1/4 inch in 15 feet toward a drip trap. Provide dirt legs at low points in the system and at major pieces of equipment.
 - M. Securely close each outlet gas-tight with a threaded plug or cap immediately after installation and keep closed until an appliance or gas fired piece of equipment is connected. When a gas fired piece of equipment or appliance is disconnected from an outlet, the outlet must be securely closed gas-tight.
 - N. Immediately after turning on the gas, inspect the piping system using a gas meter and methods described in NFPA - Number 54. When a leak is found, shut off the gas until the leak is repaired. The test shall then be remade until no leakage is detected.
 - O. After piping has been inspected, fully purge all gas piping. To purge the gas piping to a piece of equipment, disconnect the pilot piping at the outlet of the pilot valve. Do not

purge piping into a combustion chamber of an appliance or into a confined space where sources of ignition exist or there is no positive means of

ventilation.

3.4 PIPE HANGERS AND SUPPORTS

A. General

1. All piping and pipe-connected equipment, including valves, meters, etc., shall be supported in a manner to prevent vibrations in the building structure.
2. Valves and other equipment requiring removal for maintenance and repair shall be supported in such a manner that additional support of the pipe will not be required when the items are removed. Inserts for attachment to concrete work shall be set before the concrete is poured. Attachments to existing concrete and masonry work shall be by use of anchor bolts with expansion shields, toggle bolts, and other means as shown or approved. Auxiliary structural steel shall be prime painted before installation.

B. Horizontal Supports - Except as otherwise indicated on the Drawings, horizontal pipe shall be supported at intervals not to exceed the following:

Material	Size	Maximum Space (ft.)
Steel	1" - 1-1/2"	6' - 0"
Over	1-1/2"	10' - 0"

C. Supports shall be manufactured by F & S, Grinnell, Elcen, B-Line, or equal. Supports for piping shall consist of PVC or galvanized brackets; stainless steel or cadmium plated hardware and galvanized or zinc plated threaded rods. Supports for use with copper pipe shall be copper, brass, or copper-clad. Rods shall not be less than 3/8" in diameter.

3.5 TESTING

- A. Prior to acceptance and initial operation, all piping installation shall be inspected and tested to determine that the materials, design, fabrication and installation practices comply with the requirements of NFPA 54.
- B. Test medium shall be air, nitrogen or carbon dioxide.
- C. Pipe joints, including welds, shall be left exposed for examination during the test.
- D. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Prior to testing, the interior of the pipe shall be cleaned of all foreign material.
- E. Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record or indicate a pressure loss due to leakage during the pressure test period. The pressure source shall be isolated before pressure tests are made.

- F. Test pressure shall be no less than 1-1/2 times the proposed maximum working pressure, but not less than 3 psig.
- G. Test duration shall be not less than 2 hour for each 500 cubic feet of pipe volume.

3.6 GAS REGULATOR INSTALLATION

- A. Install regulator in the location shown on the drawings.
- B. Clean the inlet to these pieces of equipment thoroughly to insure that no foreign matter will be forced into the regulator or gas meter. Cap inlet line for future connection.
- C. Remove all shipping pins, plugs or miscellaneous packing materials.
- D. Mount regulator in horizontal runs of pipe. Mount unit upright and level.
- E. The Contractor shall insure that no pipe jointing compound or foreign matter shall enter the regulator.
- F. The Contractor shall provide independent vent piping for each regulator.
- G. The Contractor shall insure that the vent opening is clean and shall provide a full size black steel vent line terminating 24 inches minimum above the roof with down- turned openings covered with bug screen.

END OF SECTION 335100

SECTION 344116 – TRAFFIC CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. Layout, installation, maintenance and removal of temporary traffic control devices to prevent users of the off-site roadways and pedestrian-ways from entering the construction areas, and to direct them around the work zone.
- B. Layout, furnish and install permanent signs as shown in the plans.
- C. Remove, store and reinstall existing signs as shown in the plans or required by construction.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 321216 – Asphalt Paving.
 - 2. Section 321313 – Concrete Paving.
 - 3. Section 321723 – Pavement Marking.

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable portions of Articles 107, 701, 703 and 720 of the latest version of IDOT's Standard Specifications for Road and Bridge Construction, the Supplemental Specifications and Recurring Special Provisions and IDOT's Highway Standards.
- B. Conform to IDOT Highway Standards included in the project details of these contract documents.
- C. Applicable IDOT Highway Standards.
- D. Conform to the latest version of the Illinois Manual on Uniform Traffic Control Devices.

1.4 SUBMITTALS

- A. Contractor to submit shop drawings prior to ordering and manufacturing any permanent signs.

PART 2 - PRODUCTS

2.1 TRAFFIC CONTROL DEVICES

- A. Temporary Traffic Control Devices: As specified in IDOT Highway Standard 701901.
- B. Sign Panels: Furnish signs of the type, color and size shown in the plans or approved by the Owner's Representative, in accordance with Section 720.04 of the latest version of IDOT's Standard Specifications, the latest version of Manual on Uniform Traffic Control Devices, and the manufacturer's instructions.
- C. Posts: Furnish telescoping square tube galvanized steel posts with galvanized sign-mounting hardware for each sign.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify existing conditions. Field verify underground utilities prior to sign installation. Primary utilities of concern of shallow depths are irrigation, electric, telephone, cable and gas.
- B. Traffic control devices shall be placed in accordance with applicable requirements and shall be subject to City and Owner's Representative review and approval.
- C. Traffic flow shall be maintained adjacent to the site, subject to City and Owner's Representative review and approval.
- D. Provide Owner's Representative and City with 72 hours notice prior to initiating traffic control.
- E. Verify sign locations will not conflict with landscaping or other obstructions.
- F. Cost related to repair damaged surface, subsurface facilities, and affected turf area shall be paid for by the Contractor at no additional expense to the Owner's Representative.

3.2 INSTALLATION

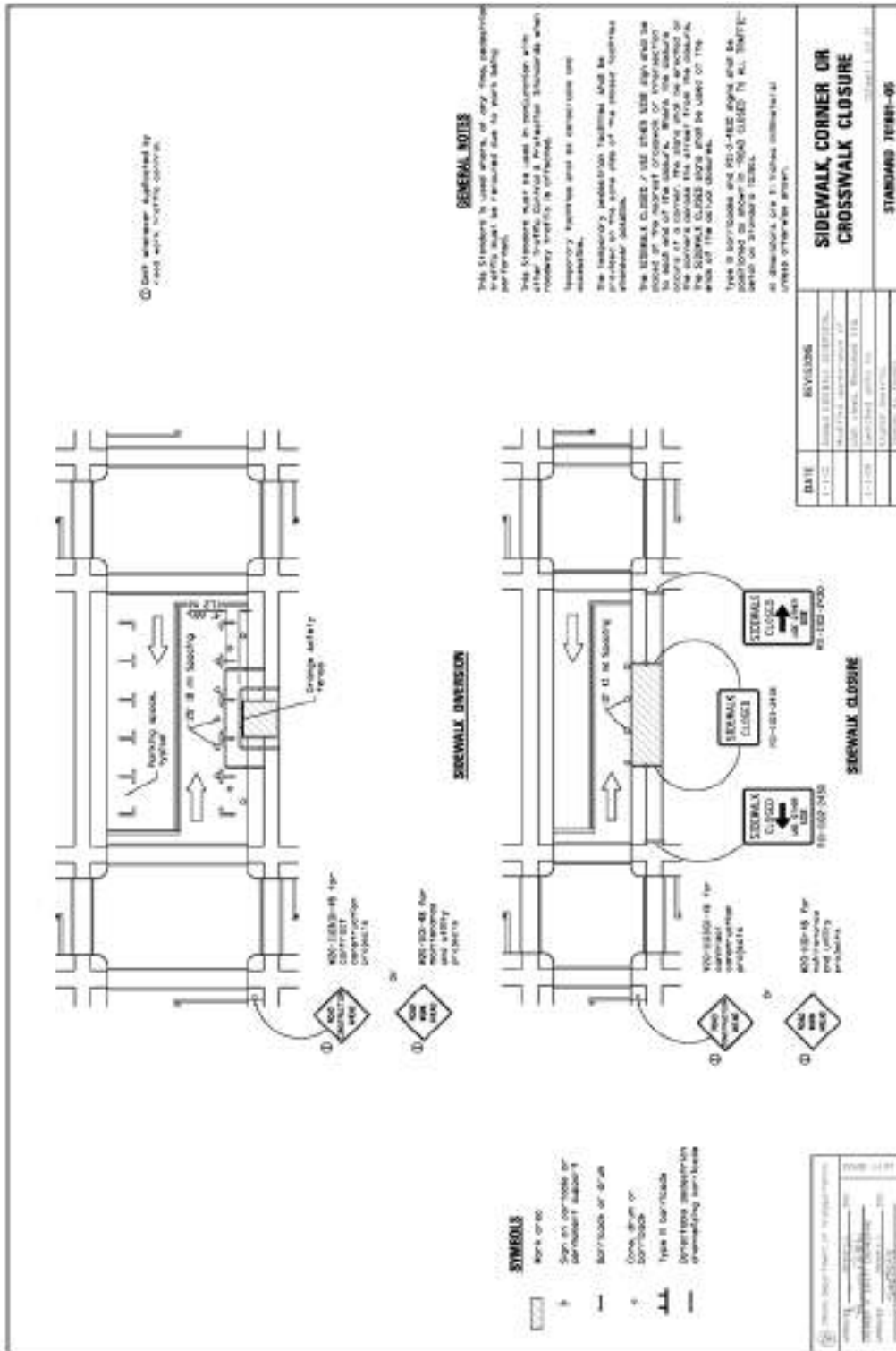
- A. Implement traffic control devices to promote flow of traffic.
- B. Ensure traffic control devices are visible at night.
- D. Install signs as shown in the approved plans.

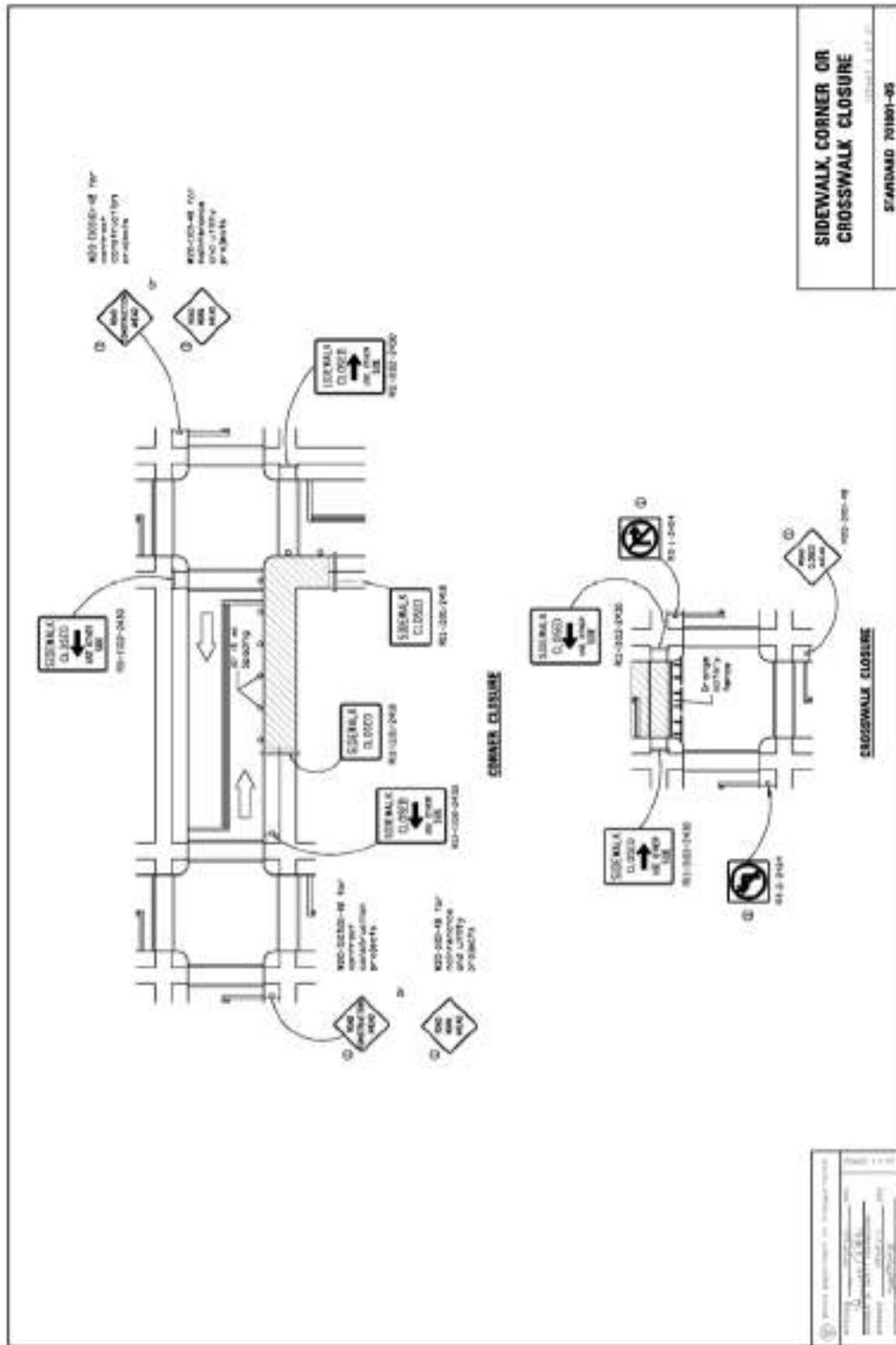
3.3 MAINTENANCE

- A. Correct traffic control devices that fail or are shifted by traffic.
- B. Adjust traffic control devices to respond to changes in traffic patterns and flow.

3.4 REMOVAL

- A. Upon final completion of the project, remove all traffic control devices.





CONE

REFLECTORIZED CONE

FLEXIBLE DELINEATOR

VERTICAL PANEL POST MOUNTED

DRUM

TYPE I BARRICADE

TYPE II BARRICADE

TYPE III BARRICADE

DIRECTION INDICATOR BARRICADE

VERTICAL BARRICADE

RETRACTABLE PERSEPTUM CHANNELIZING BARRICADE

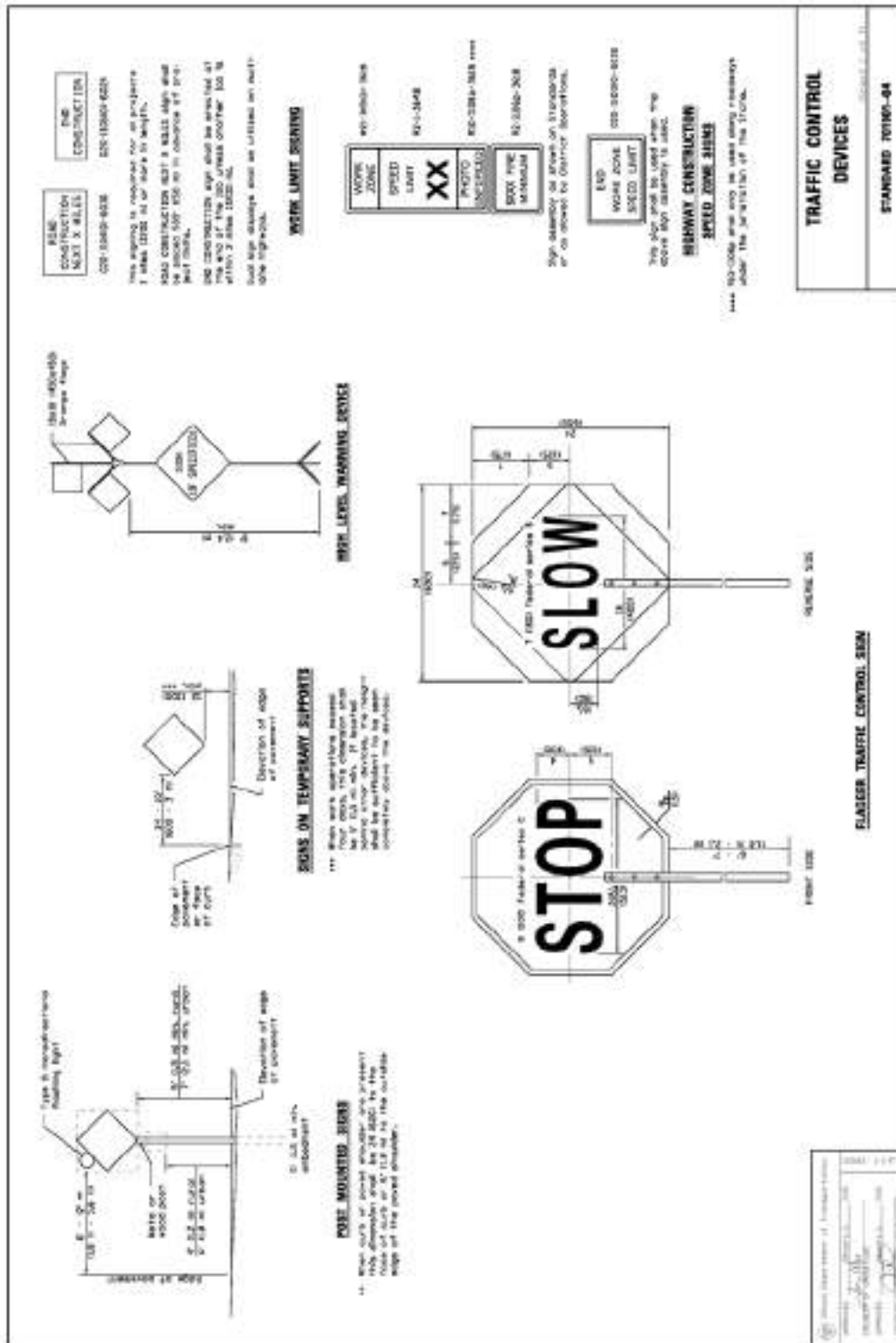
GENERAL NOTES
 All heights are measured above the pavement surface.
 All dimensions are in meters unless otherwise stated.

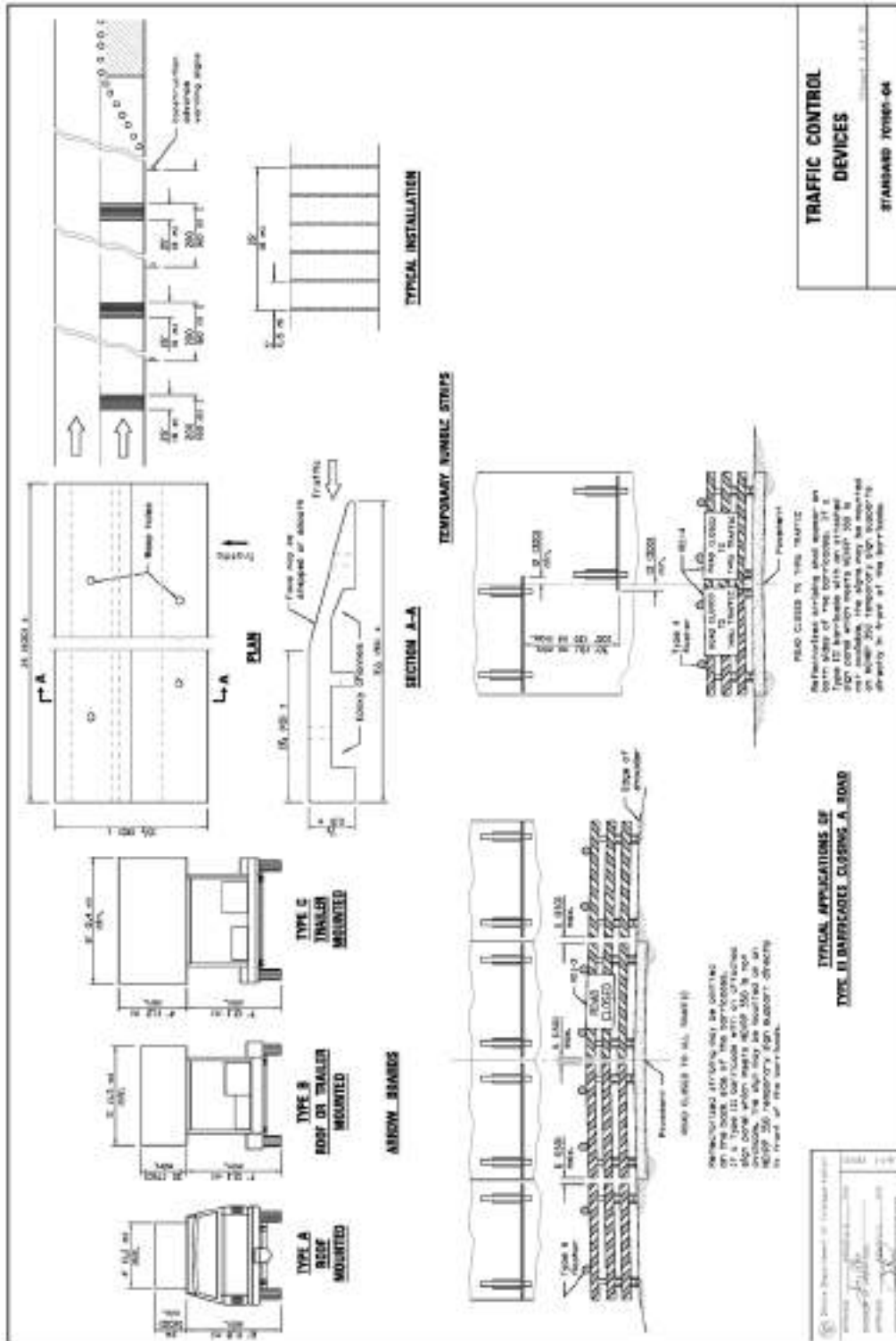
TRAFFIC CONTROL DEVICES

STANDARD T0100-04

DATE	REVISIONS
11/13	Revised for 2011 Edition of the Manual of Practice.
11/13	Added notes and symbols for 2011 Edition.
11/13	Revised Figure T0100-04.
11/13	Added Figure T0100-04.
11/13	Added Table T0100-04.
11/13	Added Table T0100-04.

* Retiring lights if required





SECTION 344117 - BICYCLE FACILITIES

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. Layout, installation, maintenance and removal of bicycle facilities, including but not limited to bicycle routes, bikeways, bike lanes, sidepaths, shared-use paths, and shared lanes.
- B. Layout, furnish and install pavement markings and signs as shown in the plans.

1.2 RELATED WORK

- A. Specified Elsewhere:
 - 1. Section 321216 – Asphalt Paving.
 - 2. Section 321313 – Concrete Paving.
 - 3. Section 321723 – Pavement Marking.

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable portions of the latest version of IDOT's Bureau of Local Roads and Streets Manual.
- B. Consult the latest edition of the AASHTO Guide for the Development of Bicycle Facilities.
- C. Consult the latest edition of National Association of City Transportation Officials' Urban Bikeway Design Guide.
- D. Consult the latest edition of the Institute of Transportation Engineers' Designing Urban Walkable Thoroughfares.
- E. Conform to the latest version of the Illinois Manual on Uniform Traffic Control Devices.

1.4 SUBMITTALS

- A. Contractor to submit shop drawings prior to installing pavement markings or ordering and manufacturing any permanent signs.

PART 2 - PRODUCTS

2.1 SIGNING, PAVEMENT MARKINGS, AND TRAFFIC CONTROL

- A. Signage, pavement markings, and traffic control for bicycle facilities shall be in accordance with the criteria presented in the latest version of the Illinois Manual on Uniform Traffic Control Devices and applicable City ordinances.
- B. Posts: Furnish telescoping square tube galvanized steel posts with galvanized sign-mounting hardware for each sign.

2.2 BICYCLE RACKS

- A. The basis of design for campus bicycle racks includes the 7-Loop Wave Style Bike Rack with a blue powder coat finish or approved equal. Submit catalog cut sheets to the Engineer for approval.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify existing conditions. Field verify underground utilities prior to sign installation. Primary utilities of concern of shallow depths are irrigation, electric, telephone, cable and gas.
- B. Signage and pavement markings shall be placed in accordance with applicable requirements and shall be subject to City and Owner's Representative review and approval.
- C. Verify sign locations will not conflict with landscaping or other obstructions.
- D. New bicycle rack locations are to be reviewed and approved by the Owner's Representative.
- E. Cost related to repair damaged surface, subsurface facilities, and affected turf area shall be paid for by the Contractor at no additional expense to the Owner's Representative.

3.2 INSTALLATION

- A. Ensure signage, pavement markings, and traffic control are visible at night.
- B. Install pavement markings and signs as shown in the approved plans.
- C. Install bicycle racks as shown in the plans. Bicycle racks are to be installed in a manner that does not impede the pedestrian route.

3.3 MAINTENANCE

- A. Maintenance responsibility for bicycle facilities shall be determined and agreed upon during the planning process. Any maintenance responsibility agreement shall be subject to

the Owner's Representative review and approval.

SECTION 344118 – PEDESTRIAN FACILITIES

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. Layout, installation, maintenance and removal of pedestrian facilities, including sidewalks or other delineated pedestrian routes.
- B. Layout, furnish and install pavement markings and signs as shown in the plans.

1.2 RELATED WORK

- A. Specified elsewhere:
 - 1. Section 321313 – Concrete Paving.
 - 2. Section 321600 – Curb Ramps.

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable portions of the latest version of IDOT's Bureau of Local Roads and Streets Manual.
- B. Conform to IDOT's Standard Specifications for Road and Bridge Construction.
- C. Conform to the Illinois Accessibility Code.
- D. Consult the latest edition of the Institute of Transportation Engineers' Designing Urban Walkable Thoroughfares.
- E. Conform to the latest version of the Illinois Manual on Uniform Traffic Control Devices.

1.4 SUBMITTALS

- A. Contractor to submit plan for each concrete pavement area to the Owner's Representative for review and approval prior to beginning paving activities.
- B. Contractor to submit plan for security barriers to the Owner's Representative for review and approval prior to installation.
- C. Contractor to submit shop drawings prior to installing pavement markings or ordering and manufacturing any permanent signs.

PART 2 - PRODUCTS

2.1 CONFIGURATION

- A. The minimum width for sidewalks is six (6) feet although ten (10) feet may be required for high-volume pedestrian areas or those serving as emergency vehicle access as determined by the Owner's Representative.
- B. The maximum cross-slope is two (2) percent.
- C. The minimum lateral separation between the edge of a sidewalk and any above-ground obstruction (e.g., posts, poles, tree trunks, utilities) is one (1) foot.
- D. Sidewalk is to be constructed of concrete in accordance to the specifications outlined in Section 321313 – Concrete Paving.

2.2 SIGNING AND PAVEMENT MARKINGS

- A. Signage and pavement markings for pedestrian facilities shall be in accordance with the criteria presented in the latest version of the Illinois Manual on Uniform Traffic Control Devices and applicable City ordinances.
- B. Posts: Furnish telescoping square tube galvanized steel posts with galvanized sign-mounting hardware for each sign.

2.3 SECURITY BARRIERS

- A. Security barriers or physical impediments shall be provided adjacent to buildings in order to provide separation between pedestrians and vehicles. Security barriers may include bollards, concrete accents, planters, or other approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify existing conditions. Field verify underground utilities prior to sign installation. Primary utilities of concern of shallow depths are irrigation, electric, telephone, cable and gas.
- B. Signage and pavement markings shall be placed in accordance with applicable requirements and shall be subject to City and Owner's Representative review and approval.
- C. Verify sign locations will not conflict with landscaping or other obstructions.
- D. Cost related to repair damaged surface, subsurface facilities, and affected turf area shall be paid for by the Contractor at no additional expense to the Owner's Representative.

3.2 INSTALLATION

- A. Ensure signage and pavement markings are visible at night.
- B. Install pavement markings and signs as shown in the approved plans.
- C. Install security barriers as shown in the approved plans.

3.3 MAINTENANCE

- A. Maintenance responsibility for pedestrian facilities shall be determined and agreed upon during the planning process. Any maintenance responsibility agreement shall be subject to the Owner's Representative review and approval.